



Identification and evaluation of pathways to Denmark for the 49 invasive alien species of union concern under EU regulation 1143/2014

Grousset, Fabienne Odette Camille; Johannsen, Vivian Kvist; Ravn, Hans Peter

Publication date:
2018

Document version
Publisher's PDF, also known as Version of record

Document license:
[Unspecified](#)

Citation for published version (APA):
Grousset, F. O. C., Johannsen, V. K., & Ravn, H. P. (2018). *Identification and evaluation of pathways to Denmark for the 49 invasive alien species of union concern under EU regulation 1143/2014*. Department of Geosciences and Natural Resource Management, University of Copenhagen. IGN Report



Identification and evaluation of pathways to Denmark for the 49 invasive alien species of union concern under EU regulation 1143/2014

Fabienne Grousset, Vivian Kvist Johannsen, and Hans Peter Ravn

Title

Identification and evaluation of pathways to Denmark for the 49
invasive alien species of union concern under EU regulation 1143/2014

Authors

Fabienne Grousset, Vivian Kvist Johannsen, and Hans Peter Ravn

Publisher

University of Copenhagen
Department of Geosciences and Natural Resource Management
Rolighedsvej 23
DK-1958 Frederiksberg C
Tel. +45 353 31500
ign@ign.ku.dk
www.ign.ku.dk

Responsible under the press law

Claus Beier

Citation

Grousset, Fabienne, Johannsen, Vivian Kvist, and Ravn, Hans Peter
(2018): Identification and evaluation of pathways to Denmark for the 49
invasive alien species of union concern under EU regulation 1143/2014.
IGN report. Department of Geosciences and Resource Management,
University of Copenhagen, Frederiksberg. 72 s. ill.

ISBN

978-87-7903-804-2

Cover layout

Jette Alsing Larsen

Cover photo

Hans Peter Ravn, *Impatiens glandulifera* (Kæmpe-balsamin/Himalayan
balsam)

The report is available electronically from

www.ign.ku.dk > Outreach > Publications

Citation allowed with clear source indication

Written permission is required if you wish to use the name of the
institute and/or part of this report for sales and advertising purposes

Contents

Abstract	4
Sammendrag	5
1. Background.....	6
2. Methodology.....	7
2.1 Identification of pathways	7
2.2 Proposed prioritization based on number of species and impact.....	9
2.3. Identification of possible measures and possible changes to priorities (section 4)	11
3. Analysis of pathways.....	13
3.1 Species of the EU List	13
3.2 Establishment, or potential for establishment in Denmark.....	13
3.3 Analysis of type of introduction, mode of entry and pathways (unintentional and intentional)	14
3.4 Analysis of unintentional pathways and their vectors	17
4. Pathways and measures	23
4.1 Escapes (zoos, pets, public estates and parks, live food for consumption, live bait, botanical gardens, fur farms).....	24
4.2 Horticulture (escape, contaminant).....	31
4.3 Secondary introduction.....	35
4.4 Aquaria (escape, contaminant)	39
4.5 Agriculture (escape, contaminant).....	40
4.6 Aquaculture (escape, contaminant)	43
4.7 Transport (travellers, vehicles and means of conveyance, leisure boats, livestock).....	45
4.8 Other-Contaminant (soil, ornamental fish, man-made goods)	50
4.9 Angling (escape, contaminant, stowaway)	52
4.10 Ballast water and sediments	54
4.11 Forestry (contaminant)	55
4.12 Medicinal (escape).....	56
4.13 Landscaping (contaminant)	57
4.14 Overview of proposed priority changes.....	57
5. Conclusion.....	58
6. References (for individual pathways, see in section 4)	60
Appendix 1. Terminology used and comparison with CBD classification.....	61
Appendix 2. Species on the EU List, status in Denmark, pathways, scores.....	65
Appendix 3. Combinations of pathways-Modes of entry for each species	71

Abstract

The present report was prepared during November 2018 by the University of Copenhagen for the Danish Ministry of Environment and Food to provide data supporting compliance with the requirements of EU Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species (EU, 2014).

The list of invasive alien species of Union concern currently contains 49 species (one of which with 3 subspecies). For each species, pathways of introduction into Denmark (all 51 species and subspecies) or of spread within Denmark (13 species and 2 subspecies that are already established) were reviewed, and their relevance and importance for Denmark assessed. This was based mostly on the EU risk assessments used to add the species to the EU List, and to additional information, where available. It was not possible in the framework of this short study to undertake a complete study of pathways.

The types of introduction, modes of entry and pathways (with vectors where possible) were determined for each species. A first prioritization of pathways was carried out based on the number of species associated with each pathway and the impact of the species as previously assessed.

Each pathway was then studied to identify potential measures that may be applied, and the priority was reassessed based on the findings.

As a result of this exercise, the pathways with the highest priority for species on the EU List were, for Denmark: escapes of pets and from zoos, escapes from horticulture, escapes from aquaria and secondary introductions (natural dispersal of species from other EU countries, or within Denmark for the species that are already established). Many other pathways were identified for the species on the EU List. Information on international guidance and measures applied in other countries were assembled. Finally recommendations on priority and priority changes are made in view of the outcomes. This analysis can then be used by the Ministry of Environment and Food to prioritize pathways and develop action plans, in compliance with EU Regulation 1143/2014.

Sammendrag

Denne rapport er udarbejdet i november 2018 af Københavns Universitet, IGN, for Miljø- og Fødevareministeriet, for at give grundlag for opfølgning på Europa-Parlamentets og Rådets forordning (EU) nr. 1143/2014 af 22. oktober 2014 om "forebyggelse og håndtering af introduktion og spredning af invasive ikkehjemmehørende arter" (EU, 2014).

Listen over invasive arter i EU indeholder aktuelt 49 arter, hvoraf en har 3 underarter. For hver art er gennemgået spredningsveje for introduktion til og inden for Danmark. Dette er baseret primært på EU's risiko vurdering der ligger til grundlag for EU listen, samt supplerende tilgængelig information hvor det kunne findes. Det var ikke muligt inden for rammerne af dette korte projekt at foretage en komplet dækkende studie af spredningsveje.

Denne rapport omfatter følgende elementer:

- Identifikation af spredningsveje for introduktion af invasive arter i Danmark og spredningsveje for allerede etablerede invasive arter
- En indledende prioritering af spredningsveje baseret på antal arter og deres indflydelse som vurderet i Madsen et al 2014 samt efterfølgende arbejde
- Identifikation af foranstaltninger der kan iværksættes for de forskellige spredningsveje
- Videreudvikling den foreslåede prioritering baseret på data og informationer om tiltag

Typer af introduktion, spredningsmåder og -veje, med vektorer, er bestemt for hver art. En første prioritering af spredningsveje blev gennemført baseret på antal arter knyttet til hver spredningsvej og indflydelsen af hver art som tidligere vurderet. Hver spredningsvej blev studeret for at identificere hvilke forebyggende tiltag der kan anvendes og prioriteringen af spredningsveje blev justeret baseret på disse analyser.

Som resultat af denne analyse blev udslip af kæledyr og zoologiske haver, udslip fra havebrug, akvarier og sekundære introduktioner de væsentligste spredningsveje i tillæg til naturlig spredning af arter fra andre EU lande eller inden for Danmark for allerede etablerede arter. Mange andre spredningsveje blev identificeret for arterne på EU listen, og informationer om andre landes vejledning og tiltag til forebyggelse blev samlet. En kort samlet sammenfatning af spredningsveje, forebyggelse og tiltag afslutter rapporten.

1. Background

The present report was prepared during November 2018 by the University of Copenhagen for the Danish Ministry of Environment and Food to provide data supporting compliance with the requirements of EU Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species (EU, 2014).

In the framework of EU Regulation 1143/2014, EU Member States endorse a “List of invasive alien species of Union concern”. This EU List currently contains 49 species (one of which with 3 sub-species). The species have been subject to a risk assessment process and it has been decided that their adverse impact required concerted action at Union level.

The regulation does not apply to invasive alien species covered under other regulations (such as plant pests or pathogens causing animal diseases).

Article 13 (Action plans on the pathways of invasive alien species) of EU Regulation 1143/2014 provides that “Member States shall, within 18 months of the adoption of the Union list carry out a comprehensive analysis of the pathways of unintentional introduction and spread of invasive alien species of Union concern at least in their territory, as well as in their marine waters as defined in point (1) of Article 3 of Directive 2008/56/EC, and identify the pathways which require priority action ('priority pathways') because of the volume of species or of the potential damage caused by the species entering the Union through those pathways.”. The analysis should be conducted at the minimum for the current 49 species of the list of invasive alien species considered to be of Union concern ("the EU list" below).

In 2014, a report on pathways for non-native species in Denmark was prepared by the University of Copenhagen for the Ministry of Environment and Food (Madsen et al., 2014). It delivered up-to-date data from literature search on pathways for 2690 species known to have been introduced into Denmark and registered in The European Network on Invasive Alien Species (NOBANIS). The study included an evaluation of species' impacts, with an analysis and prioritisation of pathways of introduced species using a scoring system (based on the Belgian HARMONIA method (also called ISEIA guidelines/protocol)), as well as suggested priority list of invasive species. Specialists of relevant taxonomic groups were involved for the further assessment of species with a high score across taxonomic groups (consensus workshop, October 2015). The Ministry of Environment and Food later further elaborated on the outcome from the consensus workshop in collaboration with Aarhus University. The result was published as Technical Report nr. 96, 2017 DCE, AAU (Strandberg, 2017).

Madsen et al. (2014) (with further work) covered impact assessment as well as analysis and prioritization of pathways for the species introduced into Denmark, and partly fulfils the EU requirements (Article 13). However, the EU List now includes 49 species, including a number of new species identified as a potential risk. Information on these species has already been compiled in Madsen et al. (2014) or at later phases. However, data on pathways need to be elaborated.

The present study has included:

- identifying pathways of introduction into Denmark, and, for species that are already present, also of spread after introduction.
- conducting a preliminary prioritisation of pathways by importance based on number of species and impacts as already evaluated (Madsen et al., 2014 with further work).
- identifying possible countermeasures that may be applied to each pathway.
- refining the proposed prioritisation using data on measures.

This analysis can then be used by the Ministry of Environment and Food to prioritize pathways and develop action plans, in compliance with EU Regulation 1143/2014.

2. Methodology

2.1 Identification of pathways

The analysis covered 51 taxa on the EU List (49 species, one of which with 3 subspecies, which are studied separately). A brief analysis is provided in section 3.1.

The EU Regulation's requirements for pathway analysis relate to unintentional pathways of introduction and spread, as intentional pathways are covered through restrictions in Article 7. For the sake of completeness, all pathways were listed in this phase, but only non-intentional pathways were detailed in the subsequent analysis, for example hitchhiking species that unintentionally enter with intentionally traded species. This is also in line with the recommendations of the European Commission DG Environment's Working Group on Alien Invasive Species (WGIAS, 2018) that a broader approach may be needed, and also takes into account that the border between intentional and unintentional is not always clear. Intentional pathways that clearly relate to trade were not detailed further, while some pathways that relate to more ambiguous cases were covered (e.g. travellers carrying an invasive alien species in their luggage).

For each species, pathways of introduction into Denmark (all 49 species) or of spread within Denmark (13 species and 2 subspecies that are already present) were reviewed. This analysis used previously assembled information (especially Madsen et al., 2014), risk assessments and complementary information available in the EU framework, information assembled by the Danish Ministry of Environment and Food (especially datasheets on individual species), as well as other relevant sources. References were listed.

In the EU framework, proposals to add species to the EU List are supported by risk assessments. For most species, additional information or evidence criteria on the 49 species were later assembled, including during a scientific workshop to complete selected invasive alien species risk assessments (EU, 2014, Roy et al., 2014). EU risk assessments for the 49 species were conducted before 2015 (first list) and 2016 (first update). The present study did not aim at gathering updated information, but new situations were noted (e.g. situation within Denmark or distribution in the EU).

The relevance for Denmark of pathways indicated in the EU risk assessment for each species was assessed. A short comment was added for pathways not considered relevant for Denmark, but in cases of absence of data allowing assessing whether a pathway is relevant, the pathway was kept. The fact that the EU Regulation is now implemented was taken into account in some cases. For example: escape from fur-farms is an unlikely pathway for a species which has never been used in fur-farms in Denmark, because use is now forbidden through the EU Regulation and subject to strict national rules.

Other comments were added relevant for unintentional pathways, especially the pathways mentioned in the EU risk assessments (which sometimes describe the potential pathways in more details), notes on spread pathways for those 13 species and 2 subspecies that are already present in Denmark, and notes on species that are not expected to establish in Denmark in present climatic conditions according to the EU risk assessments. Issues such as volume of the pathway, number of individuals, frequency of entry event, temporal evolution of the pathway were also considered, but limited information was available in the main sources used (EU risk assessments and material from the Ministry of Environment and Food). The temporal evolution of pathways was also considered when detailing pathways (see below).

It is worth noting that the EU risk assessments for the 49 species vary in their manner of dealing with pathways (e.g. sometimes an exhaustive list, sometimes main pathways), and in the area covered: the whole EPPO region (for plants, when an EPPO PRA was conducted), the whole or part of the EU, or individual countries. In the latter case, certain pathways may not have been considered relevant in the EU risk assessment. This is particularly the case of natural dispersal (e.g. for risk assessment conducted in the UK). In the present study, the possibility of entry into Denmark through natural spread from other countries was considered for each species, based on the information available in the EU risk assessments or complementary information. The species distribution (hence the risk of natural dispersal into Denmark) may have changed since. Distributions could not be updated in the framework of this study, but any changes were noted when found.

The working spreadsheet provided by the Ministry of Environment and Food already contained information, which was modified, where necessary, using EU and Danish information. The type of introduction, mode of entry, pathways, as well as other details on pathways were compiled in the revised spreadsheet (Annex to this report). All pathways with a component of unintentionality are in bold. Any changes to the previous list were clearly identified with colours for the sake of trace-back. For species established in Denmark, pathways for spread were indicated in the same column as pathways for introduction (but were clearly marked when relevant only for spread). Vectors were indicated when information was available. In addition to the vectors used in Madsen et al. (2014), several new vectors were added to allow describing vectors that would otherwise fall under the category ‘Other’.

In the previous analysis for species established in Denmark, the category ‘not known’ was used when no information was available on modes of entry of pathways for previous introduction into Denmark. However, here the assessment relates to potential pathways of introduction and is further elaborated using the EU risk assessments, and data was therefore always available.

In order to allow consistency of data already assembled for Denmark for over 2690 non-native species (Madsen et al., 2014), the same pathway terminology was used here for the 49 species of the EU List. However, after the 2014 study, a ‘Categorization of pathways for the introduction of alien species’ has been developed in the framework of the Convention on Biological Diversity (CBD) (see details in Box 1). For transparency, the correspondence of the pathways of introduction into Denmark (not of spread within Denmark) with the CBD classification was indicated. This was modified from WGIAS (2018), which provided a summary of introduction pathways for the 49 species according to the EU risk assessments, and the corresponding introduction pathways according to the CBD terminology. Changes to WGIAS (2018) were left visible and comments added in some cases.

Finally, when found, information was added to the spreadsheet on other elements, such as habitats preferred by the species.

Box 1. Terminology for pathways

The framework of initial introduction of alien species into a new region developed by Hulme et al. (2008) proposed terms to describe the pathways and mechanisms of introduction of alien invasive species. Building on Hulme et al. (2008), pathway classification systems have been refined over the past years, leading to the development of the CBD Categorization of pathways for the introduction of alien species (CBD, 2014; Blackburn et al., 2014). The use of the CBD classification was recommended to EU member countries when implementing Regulation 1143/2014, in order to enable a comparison across countries and regions, and ensures transparency in the process (Working Group on Invasive Alien Species, 2018, below WGIAS, 2018).

The study conducted for Denmark in 2013 and published in 2014 (Madsen et al., 2014) based its pathways categories on the terminology used at the time in the NOBANIS framework and on Hulme et al. (2008). Pathways were described using:

- Type of introduction: intentional, unintentional;
- Mode of entry: release, escape, stowaway, corridor, unaided, not known;
- Pathway of introduction and their subcategories (or vectors), which describe the pathways in more details.

Because this terminology had already been used to assemble pathway information for over 2690 non-native species in Denmark (Madsen et al., 2014), and to allow consistency of data for Denmark, the same terminology is used here. However, for transparency and understanding, it was indicated how these categories correspond to the CBD system, and a table of corresponding terminology is provided as Appendix 1 (for information and does not constitute an agreed list).

The two systems are constructed differently, and one CBD pathway subcategory may apply to several pathways in the present study and in Madsen et al. (2014). However, a combination Mode of entry/Pathway can be related to a CBD pathway Category/Subcategory.

Although the CBD classification provides many subcategories, intended to cover all possible pathways for invasive species, relatively few are used to describe the pathways for the 49 species on the EU List (Annex 1 of WGIAS, 2018). Therefore, the differences that are evident from Appendix 1 do not result in major differences between categories of Madsen et al. (2014) and the CBD classification for the 49 species of the EU List.

Use of the CBD pathway terminology is recommended, and would help understanding international harmonisation. However, converting the pathways for Denmark into the CBD terminology is not a straightforward operation, and cannot be done automatically.

Finally, a better definition/description of pathways may also be desirable to allow consistency at the international level.

OUTCOME

The outcome of this exercise is a revised spreadsheet for the 51 EU species and subspecies of the EU List. Basic information on each species is provided in Appendix 2. (Detailed comments on pathways, CBD categories and other information are only in the complete spreadsheet - Annex to this report).

2.2 Proposed prioritization based on number of species and impact

First step (section 3.3)

The type of introduction, mode of entry and pathways (intentional and unintentional) were analysed. Given the small number of species, this was not done for detailed taxonomic categories (as in Madsen et al., 2014), but for ‘plants’ and ‘animals’, separating between ‘aquatic’ and ‘terrestrial’. For the same reason, percentages were not used.

Second step (section 3.4)

Unintentional pathways were rated according to the number of species associated with them, as well as to the species invasiveness/impact as scored in the information provided (original spreadsheet). Methods similar to Madsen et al. (2014) and NOBANIS (2015) were used.

Although it is recommended that the pathways are rated according to the volume of the species entering the Union through these pathways, or the potential damage caused by these species (Article 13:1), it is also recognized that data is often lacking, and that a simplified approach may be used (WGIAS, 2018). However, because such factors influence the priority of pathways, some elements were assembled when considering priority groupings.

The analysis was first performed for unintentional pathways as a whole (e.g. Horticulture). However, the possible mitigation of an unintentional pathway may be linked to the Mode of entry. For example, for Horticulture, an invasive plant may present a risk in itself because it may Escape, or it may be a Contaminant of other plants in trade. This will influence measures that can be applied, authorities and stakeholders that need to be involved, and systems that can be put in place at the national level. Therefore, it was useful to take account of the Mode of entry, so that priority can be given if necessary to the most important combinations of Pathway-Mode of Entry. Consequently, pathways that may present several modes of entry were identified, and the combinations of Pathway/Mode of entry were determined for each species.

In relation to the CBD categories, the analysis performed here has a more detailed level for some pathways, and therefore results in allocating different priorities to pathways which may be grouped in the same priority category if analysed according to the CBD categories. For example, the CBD ‘Contaminant on plants (except parasites, species transported by host/vector)’ would add Horticulture-Contaminant, Forestry-Contaminant, Landscaping-Contaminant, Agriculture-Contaminant.

Regarding impact, as stated by WGIAS (2018), the EU Regulation ‘aims primarily to address the negative impacts of invasive alien species on biodiversity and ecosystem services, while impacts on human health and the economy are considered as aggravating factors.’. Similarly, the IUCN has recently developed an Environmental Impact Classification of Alien Taxa (EICAT) that classifies alien species into one of five categories, according to the magnitude of the detrimental impacts to the environment (IUCN, 2017 – see Box 2). This system aims at harmonizing the evaluation of impacts of different alien species.

In Madsen et al. (2014) (and further work), the total impact score for a species is the total of four scores for HARMONIA categories of environmental impact (dispersal potential, colonization of high conservation value habitats, adverse impacts on native species, alteration of ecosystem functions) and two additional scores for economic and human health impact assessments.

The analysis here was based on the scores in Madsen et al. (2014) with further work. The impact scores obtained as per Madsen et al. (2014) (and further work) cannot be converted directly into EICAT categories (see Box 2). However, the EICAT categories seem to relate mostly to impacts on native species and ecosystems. Consequently, the pathways were analysed using both **the total impact score and the sum of two environmental scores (adverse impacts on native species, alteration of ecosystem functions)**.

Box 2. EICAT impact categories (IUCN, 2017)

According to the EICAT system, species are rated in one of 5 categories of impact: Minimal concern, Minor, Moderate, Major, Massive, following a decision-making scheme that considers effects on native species and ecosystems. However, allocation between categories requires an analysis addressing issues such as declines in the population size of native species, or reversibility of changes.

Conversion of the HARMONIA scores into the EICAT system is not straightforward, especially since reversibility is not part of the HARMONIA protocol. However, an approximation could be useful in order to not re-evaluate all organisms (not only the 49, but possibly all other non-native species). A suggestion is presented here.

An approximation, using the scores for Adverse impacts on native species (score 1-3) and Alteration of ecosystem functions (score 1-3), may be considered as a first step (a biological impact score), but would need further study.

Minimal 1 + 1

Minor if one score is 1 (and the other is 2 or 3)

Moderate 2 + 2

Major if total = 5

Massive if total = 6

Graphs were produced that showed broad groups of Pathways-Mode of entry. Additional considerations were made regarding the fact that some species are not expected to establish in Denmark, although it is recognized that establishment potential may change in the future (e.g. with climate change). Similarly, elements relating to the volume (number of introduction events, number of units introduced) were considered where relevant. Some pathways were given a higher priority because of high biological impact of the species associated with them.

The present study is limited to the 49 species of the EU List, and the resulting recommendations complement the existing prioritization of pathways that included all species introduced into Denmark and some species identified as a risk.

OUTCOME

As a result of this exercise, the combinations of Pathway-Mode of Entry could be separated into four broad priority groups (section 3.4). The analysis briefly commented the difference in pathway prioritization in the present exercise and in Madsen et al. (2014).

2.3. Identification of possible measures and possible changes to priorities (section 4)

Potential measures to prevent or reduce introduction and spread of the species of the EU List as associated with the pathways were searched. They included consideration of voluntary action and codes of good practice (WGIAS, 2018). A review of current recommendations was performed.

For each Pathway or combination Pathway-Mode of entry of the four priority groups (sections 4.1 to 4.13), the following was assembled:

- Brief description of the pathway, including consideration of possible vectors, species associated and whether subgrouping would be feasible and relevant (e.g. squirrels)
- Stakeholders that may be involved
- Measures that have been applied in Denmark against some species relevant for the pathway
- Existing international guidance on management of the pathway. This focused on specific guidance. More general elements can also be found in Scalera & Genovesi (2016).
- Measures applied in other countries (EU, or broader).
- Where possible, consideration of aspects that may influence priority and management, such as volume, feasibility, acceptability of the measures, aspects for which further information is needed.
- Proposed changes to the priority group defined as per 2.2 (also summarised in section 4.14).

The information may not be exhaustive as there was limited time to perform this analysis.

Where vectors had been identified, this analysis was done at the level of vectors (for example pets or zoos are treated separately under Escape).

The experience of other countries in terms of measures applied is very valuable, but one would need to consider how it applies to Denmark in terms of feasibility, acceptability by the authorities and by stakeholders (incl. the general public), cultural and sociological aspects of the application of control measures on some invasive species, etc.

The Danish legislation was not studied in details. Some pathways may already be partly covered. This would need further consideration at a next step.

The CBD recommends that prioritization, in addition to measures, should take account of feasibility of management, conservation benefits and the likelihood of management success for a given level of investment (cost-effectiveness) and social preference. Elements were added when information was found, but it was not possible to conduct a complete analysis, and the present study focused in the technical analysis of pathways. These elements will need to be considered during the prioritization by the Ministry of Environment and Food at a later stage.

Similarly, some methods recently developed take account of conservation value and vulnerability of the areas where the introduction and initial spread will occur (McGeoch et al., 2016). It was not possible to take this into account in this preliminary short analysis and would require the involvement of environment and organisms experts.

The data assembled are not complete, but outline elements that could be completed and refined in order to prioritize pathways and propose action plans.

The measures identified may allow covering other species on the pathway. For all species in the EU List, the current prohibitions in the framework of the EU Regulation may lead to shifts in the species used, which in turn may lead to introducing new potentially invasive alien species.

Finally, the analysis of possible measures was used to consider whether changes should be proposed to the prioritization of pathways (section 4.14).

OUTCOME

Tables for combinations pathways-modes of entry or vectors, including measures (sections 4.1 to 4.13).
Summary of proposed priority groups and changes (section 4.14).

3. Analysis of pathways

Box 3 Reminders

- The present analysis applies to Denmark. The types of introduction, modes of entry and pathways/vectors refer to Denmark, even if this is not specified.
- The abbreviations used for pathways are given in Appendix 1.
- In order to avoid repetition, ‘Aquatic/terrestrial plants/animals’ refers to the 49 species of the EU List (unless otherwise specified)

3.1 Species of the EU List

The present analysis covers the 51 species and subspecies of the “List of invasive alien species of Union concern” (or EU List below). *Trachemys scripta* has 3 subspecies that are studied separately here. Appendix 2 provides the list of species as well as basic data (other data is only in the complete spreadsheet).

The EU List contains 23 plants and 28 animals, representing 6 broad taxonomic groups (Fig. 1). This is much more restricted than the analysis of pathways for non-native species in Denmark (referred throughout below as Madsen et al., 2014), which covered over 2600 species in 19 taxonomic groups. Some taxonomic groups are represented by only one species, such as terrestrial arthropods (*Vespa velutina nigrithorax*).

The EU List contains 22 aquatic species and 29 terrestrial species (Fig. 2). Because of the small number of species on the EU List, the analysis below was made for the categories aquatic plants, terrestrial plants, aquatic animals and terrestrial animals. Subcategories were considered in the detailed analysis of unintentional pathways, as relevant.

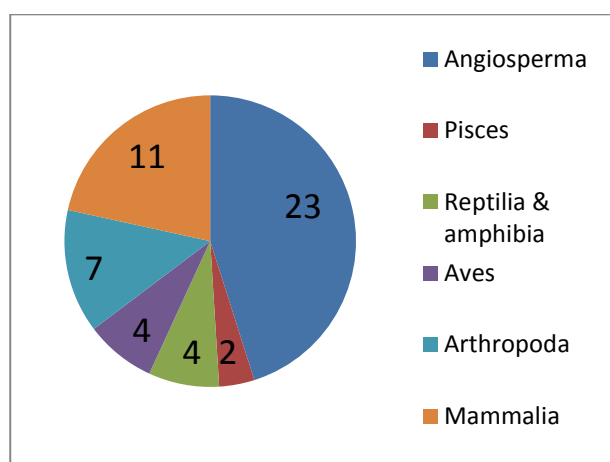


Fig. 1. The 51 Species and subspecies of the EU List by taxonomic group

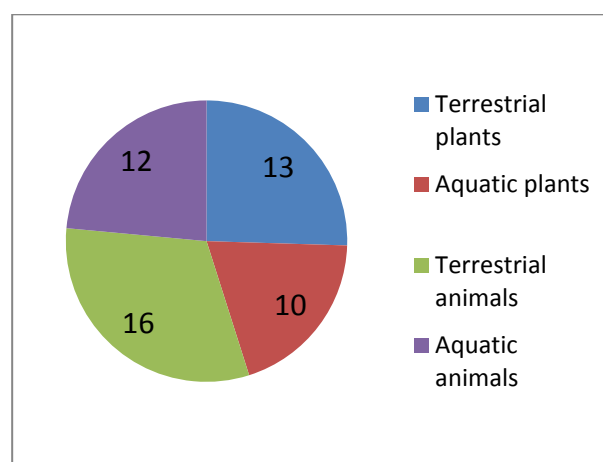


Fig. 2. Number of terrestrial and aquatic plants and animals

3.2 Establishment, or potential for establishment in Denmark

Whether the species is already established in Denmark, could be expected or is not expected to establish may influence the relevance of individual pathways and their prioritization. Information on whether species are established in Denmark was provided in the original spreadsheet.

Fifteen species and subspecies are already established in Denmark, 13 species and 2 subspecies of *Trachemys scripta* (Table 1). Another 5 have been registered in the past, but are not currently established.

Among the 36 species and subspecies that are not established in Denmark, 7 are not considered currently able to establish according to the EU risk assessments and additional information assembled in the framework of the EU. A conservative approach was applied: only species for which the EU risk assessments and additional EU information gave clear indications that establishment was not likely to occur in Denmark, northern Europe or Scandinavia are listed in Table 2. All others (29 species) were considered as potentially able to establish. It is noted that the potential of species to establish may change in the future, especially with climate change, and this is considered when studying the pathways.

Established in Denmark	
Angiosperms	<i>Cabomba caroliniana</i>
Angiosperms	<i>Elodea nuttallii</i>
Angiosperms	<i>Heracleum mantegazzianum</i>
Angiosperms	<i>Heracleum persicum</i>
Angiosperms	<i>Heracleum sosnowskyi</i>
Angiosperms	<i>Impatiens glandulifera</i>
Angiosperms	<i>Lysichiton americanus</i>
Arthropods	<i>Eriocheir sinensis</i>
Arthropods	<i>Pacifastacus leniusculus</i>
Aves	<i>Alopochen aegyptiaca</i>
Mammalia	<i>Nyctereutes procyonoides</i>
Mammalia	<i>Ondatra zibethicus</i>
Pisces	<i>Pseudorasbora parva</i>
Reptilia	<i>Trachemys scripta elegans</i>
Reptilia	<i>Trachemys scripta scripta</i>

Table 1. Species already established in Denmark

Not currently expected to establish in Denmark	
Angiosperms	<i>Alternanthera philoxeroides</i>
Angiosperms	<i>Eichhornia crassipes</i>
Angiosperms	<i>Parthenium hysterophorus</i>
Angiosperms	<i>Persicaria perfoliata</i>
Angiosperms	<i>Pueraria lobata</i>
Mammalia	<i>Herpestres javanicus</i>
Mammalia	<i>Myocastor coypus</i>

Table 2. Species currently unlikely to establish in Denmark

3.3 Analysis of type of introduction, mode of entry and pathways (unintentional and intentional)

For the 51 species and subspecies, the type of introduction, mode of entry and pathways are detailed in Appendix 2. This first analysis covered both unintentional and intentional pathways, while the further analysis focuses on unintentional pathways.

Because of the small number of species, this analysis was not made for detailed taxonomic categories (like in Madsen et al., 2014), but for ‘plants’ and ‘animals’, separating between ‘aquatic’ and ‘terrestrial’. For the same reason, percentages were not used.

PLANTS

Type of introduction (Fig. 3)

All aquatic plants and most terrestrial plants may be introduced intentionally, or by a combination of intentional and unintentional introduction. None of the aquatic plants is being introduced only unintentionally and only two terrestrial plants.

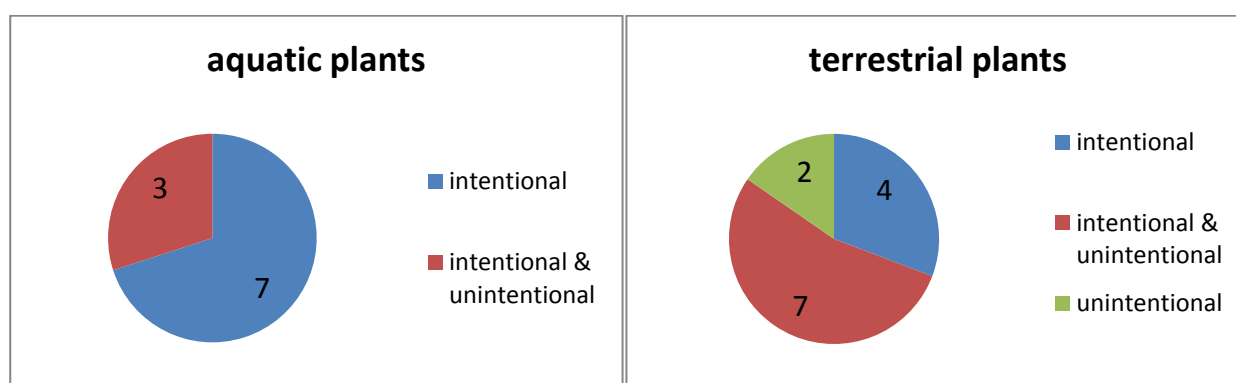


Fig. 3. Types of introduction for plants

Modes of entry (Fig. 4)

Escape is the main mode of entry for aquatic plants. 7 aquatic plants may enter only through escape, while the remaining 3 have 3 modes of entry. Modes of entry are more variable for the 13 terrestrial plants. While Escape also dominates (9 species), entry as Contaminant, Release or Stowaway are also significant. Finally, Unaided entry applies to only 4 plants.

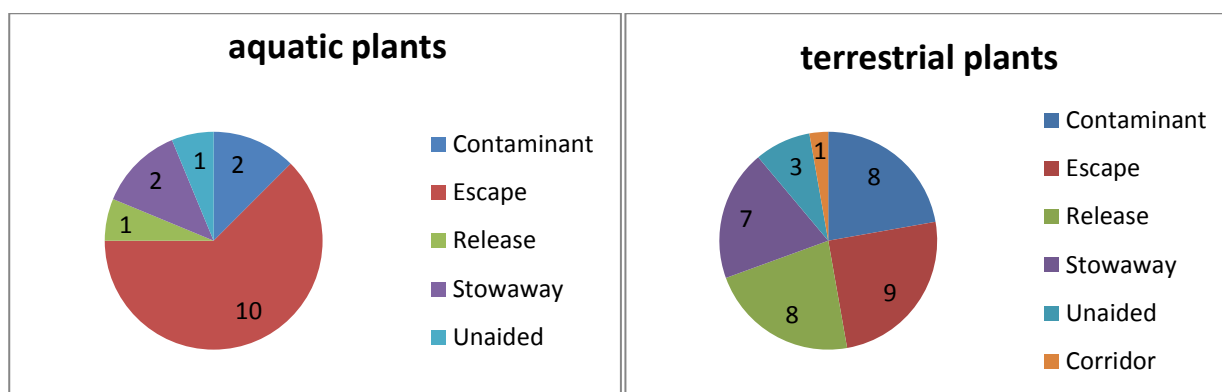


Fig. 4. Modes of entry for plants

Pathways (intentional and unintentional) (Fig. 5)

The pathways for aquatic and terrestrial plants (intentional and unintentional) are presented in Fig. 5.

Terrestrial plants (13 species)

Between 1 and 6 potential pathways were identified for each terrestrial plant. All species but one have Horticulture as a potential pathway.

The pathway Secondary introduction applied to the 6 species already established in Denmark.

Transport is a pathway for 7 species, mostly through machinery and vehicles (vectors are considered in more details in section 3.6).

Finally, 8 species can be transported on Other pathways, which were either soil (5), use for beekeeping (3) or both (1).

Aquatic plants (10 species)

Aquatic plants have between 1 and 5 pathways, with Horticulture (all 10 species) and Aquaria (8 species) dominating, as many of the plants are used indoors in aquaria or outdoors in garden ponds etc. 4 species have only Horticulture and Aquaria as pathways, and 2 others only Horticulture (*Ludwigia peploides* and *Eichhornia crassipes*, the latter is considered unlikely to establish in Denmark under current conditions). As for terrestrial plants, the pathway Secondary introduction applied only to the 2 species already present in Denmark.

Angling, identified as a pathway only for *Elodea nuttallii*, applies to its further natural spread in Denmark, and not to introduction.

Excluding from the analysis the 3 terrestrial and 2 aquatic species that are currently unable to establish would remove the only cases of Medicinal (*Persicaria perfoliata*) and Ballast (*Alternanthera philoxeroides*, and *P. perfoliata*). For other pathways, it would only change the number of species per pathway.

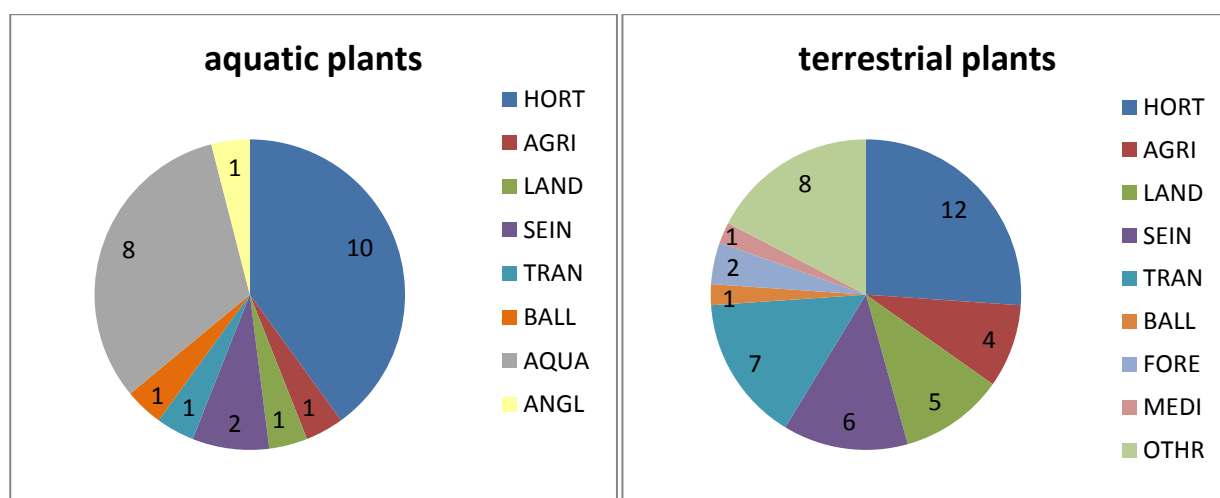


Fig. 5. Pathways of introduction (and spread for established species), both intentional and unintentional for plants

ANIMALS

Type of introduction (Fig. 6)

As for plants, all aquatic animals and most terrestrial animals may be introduced either intentionally, or by a combination of intentional and unintentional introduction. None of the aquatic animals are being introduced only unintentionally and only 2 terrestrial animals.

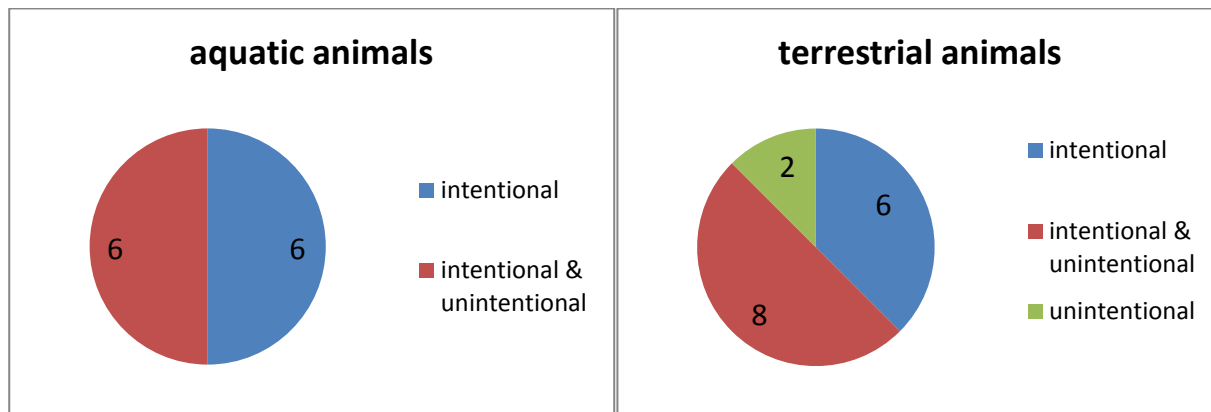


Fig. 6 Types of introduction for animals

Modes of entry (Fig. 7)

Escape is the main mode of entry for all animals. It applies to all 12 aquatic animals and to 14 terrestrial animals (out of 16).

5 species of aquatic animals may enter as contaminants, but only 1 terrestrial animal (the wasp *Vespa velutina*).

Unaided entry from countries where the species occur applies to 9 terrestrial species, including the 4 birds on the EU List, and 7 aquatic animals.

Most species have several modes of entry.

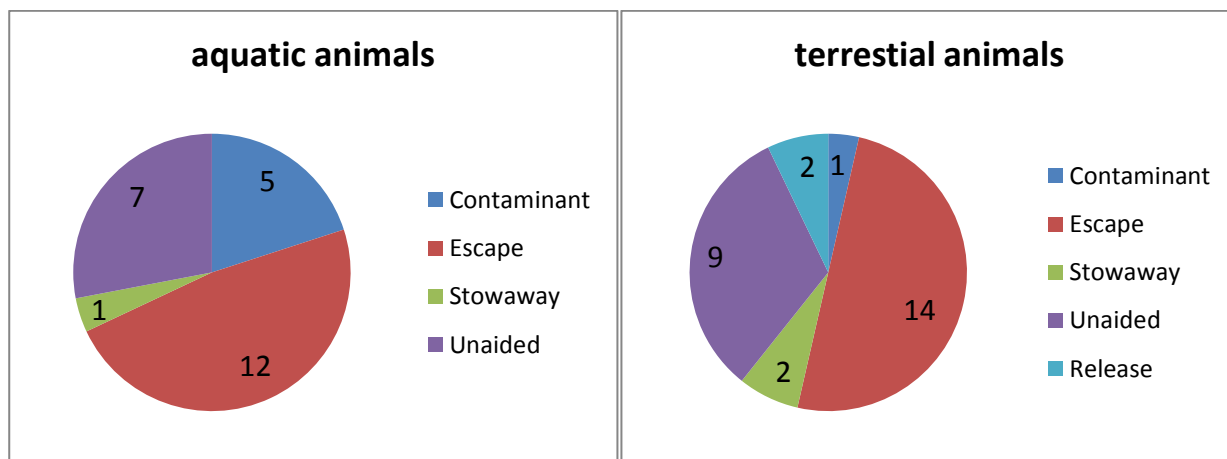


Fig. 7. Modes of entry for animals

Pathways (intentional and unintentional) (Fig. 8)

The pathways for aquatic and terrestrial animals (intentional and unintentional) are presented in Fig. 8.

Terrestrial animals (16 species)

Species have between 1 and 3 potential pathways, except the wasp *Vespa velutina*, which has 6.

Escape is by far the most frequent pathway (14 species).

The pathway Secondary introduction applies to several species that are present in northern Germany or are likely to disperse at longer distance by flight from their current distribution in Europe. It also applied to species established in Denmark.

Transport by ship was a possible pathway for the hitchhiker bird *Corvus splendens* and mammal *Herpestes javanicus* (the latter unlikely to establish in Denmark).

The pathway Other related to Release into public estates and parks for the goose *Alopochen aegyptica*, and Man-made goods for the wasp *Vespa velutina*. It is worth noting that *Vespa velutina* presents the only cases of pathways Agriculture, Horticulture, Forestry and Other (man-made goods) for animals.

Aquatic animals (12 species)

Between 1 and 5 pathways were identified for aquatic animals. Aquaria is not surprisingly a pathway for many species (10), while Escapes and Secondary introduction come next (7 species each). Also unsurprisingly, this is the only group for which the pathway Aquaculture applies.

Excluding from the analysis the species that are not currently likely to establish (*Herpestres javanicus*, *Myocastor coypus*) would not change the analysis significantly.

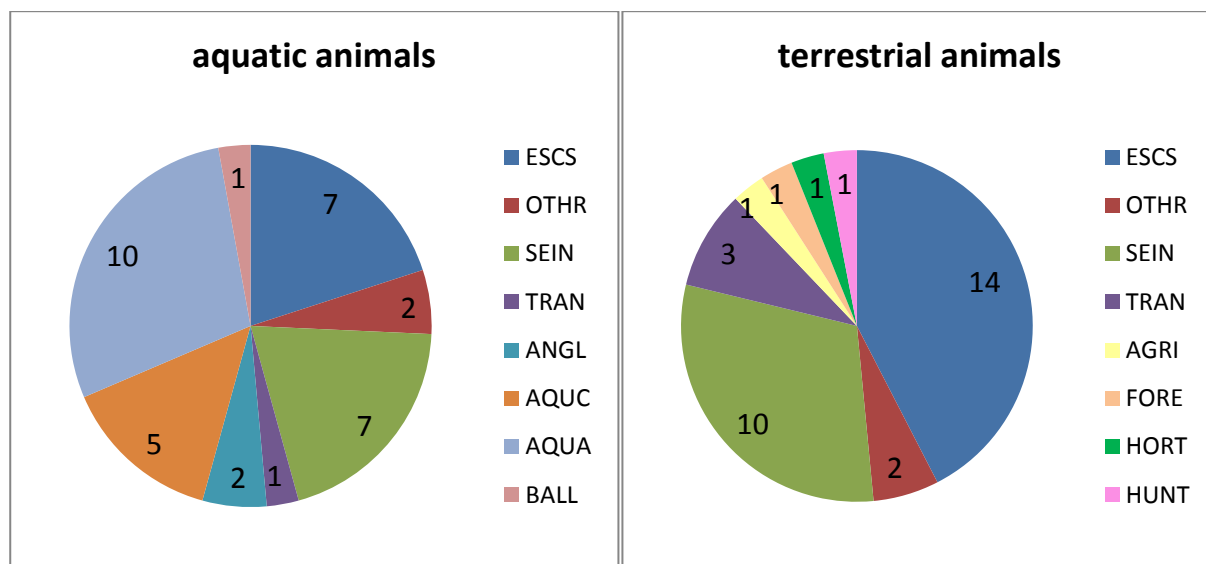


Fig. 8 Pathways of introduction (and spread for established species), both intentional and unintentional for animals

3.4 Analysis of unintentional pathways and their vectors

The unintentional pathways represented in the analysis for the 49 species of the EU List are presented in Table 3.

The combinations of pathway-mode of entry for each species are given in Appendix 3.

abbreviation	Pathway	Mode of entry
AGRI	Agriculture	Escape, Contaminant
ANGL	Angling/sport	Release, Escape, Contaminant, Stowaway
ANIM	Animal husbandry	Contaminant
AQUC	Aquaculture	Escape, Contaminant
AQUA	Aquaria	Escape, Contaminant
BALL	Ballast water & sediments	Stowaway
BIOC	Biological control	Release
COMC	Commodity contaminants	Contaminant
ESCS	Escapes	Escape
FORE	Forestry	Escape, Contaminant
HORT	Horticulture	Escape, Contaminant
HULL	Hull fouling	Stowaway
HUNT	Hunting	Release
LAND	Landscaping	Release, Contaminant
MEDI	Medicinal	Release, Escape
REIN	Reintroduction	

abbreviation	Pathway	Mode of entry
SEIN	Secondary introduction	Corridor, Unaided
TRAN	Transport	Stowaway
OTHR	Other	Release, Escape, Contaminant
NOTK	Not known	

Table 3. in black, unintentional pathways and modes of entry relevant to species of the EU List (in grey, pathways/modes of entry that were not relevant - but may be amongst intentional pathways for some species)

An analysis was first performed of the number of species in 3 categories of total impact score (i.e. environmental, economic and health impacts) for the unintentional Pathways, not considering a division into Mode of Entry (Fig. 9; total impact score 6-10/11-13/14-18).

The combinations pathways-mode of entry were then analysed using:

- the total impact score (i.e. environmental, economic and health impacts)
- the biological impact score of the species (sum of 'impact on native species' and 'impact on ecosystems').

In each case, the importance of the pathway was illustrated by:

- the number of species in each of 3 categories (Fig. 10 for total impact score 6-10 / 11-13 / 14-18; Fig. 12 for biological impact score 2 / 3-4 / 5-6).
- the score for all species on the pathway (sum of scores for each species) (Fig. 11 and Fig. 13)

The category Secondary introduction had been used to indicate the possible spread of the species within Denmark for species that are already established. Cases where Secondary introduction applies only to spread within Denmark were separated. The same approach was used for the pathway Transport, which also sometimes applied only for spread within Denmark.

Following this analysis, the Pathways or combinations Pathway-Mode of entry were classified into four broad groups taking account of the number of species associated and impact, with additional considerations. The terms High-Medium-Low-Very low are used here to differentiate the priority groups clearly, but this does not prejudge of whether measures should be taken or not (i.e. it may be necessary to take measures on Low or Very low priorities).

High priority (Group A): Horticulture-Escape, Escapes (incl. pets, zoos etc.), Aquaria-Escape and Secondary Introduction

These pathways or combinations contain at least 15 species, with at least 4 species with major total impact. Horticulture-Escape, Escapes and Secondary Introduction dominate by the number of species and total score, both for the total impact score and biological impact.

In addition, Aquaria-Escape covers major species when considering biological impact, although mostly species of medium importance when considering the total score. The pathway Aquaria did not rate high in Madsen et al. (2014), but in the present analysis this reflect the relatively large number of aquarium plants and animals on the EU list.

The Secondary Introduction pathway is even more important when considering cases where it only applies to spread. Many species on the EU List are already established in the EU. This pathway applies especially to species that are present in Germany with a distribution that could indicate that spread is possible, or species in other countries with higher dispersal capacity (the birds). This pathway was more important than in Madsen et al. (2014) as most species are already present in the EU or in Denmark.

Medium priority (Group B): Horticulture-Contaminant, Aquaculture-Contaminant, Other-Contaminant, Transport, Agriculture-Contaminant

This group covers pathways with 4-14 species, including some causing major impact.

Transport is even more important when considering cases where it applies only to spread within Denmark, but still falls in this group. However, it applies to very different vectors, which are dealt with separately in section 4. Transport was as important as Escapes (in number of species) in Madsen et al. (2014).

Other-Contaminant applied to 6 species that can be introduced as contaminant of soil (as a commodity on its own) (*Baccharis halimifolia*, *Heracleum mantegazzianum*, *Heracleum persicum*, *Heracleum sosnowskyi*, *Microstegium vimineum*, *Persicaria perfoliata*). This pathway may be underestimated here because the

pathway soil (as a commodity) was not mentioned in several EU risk assessments for plants for which soil associated with plants for planting was considered a potential pathway.

Other-Contaminant also applied to contamination of ‘ornamental’ fish (*Orconectes limosus*), and of man-made goods (*Vespa velutina*).

Secondary Introduction, when applied only to spread within Denmark, would fall into this group. However, because similar measures apply, it was covered in Group A.

Low priority (Group C). Aquaculture-Escape, Other-Escape, Forestry-Contaminant, Ballast

These combinations cover either 2 or 3 species. Most of these groups contain some species of major total impact. Aquaculture-Escape contains 2 species of major biological impact, and was therefore included in this category. Forestry-Contaminant does not contain major species in terms of total impact, but in terms of biological impact. Ballast was more important in Madsen et al. (2014), but here includes only 3 species (two of which are plants).

Some pathways (esp. here Forestry, or below Agriculture and Landscaping) show a minor importance here compared to the results of Madsen et al. (2014). This is especially because there are no plant pests (other than invasive plants themselves) on the EU List. However, these pathways apply to many species that may have tremendous impact on the environment.

Very low priority (Group D). Agriculture-Escape, Angling-Escape, Angling-Contaminant, Angling-Stowaway, Aquarium-Contaminant, Landscaping-Contaminant, Medicinal-Escape

These pathways apply to one species (also if major) or two species (none major). Angling would be in group C if considering all modes of entry together.

3.5 Consideration of species currently unlikely to establish in Denmark

The final prioritization may wish to focus on species that are likely to establish in Denmark. However, recognizing that this may change in the future, and that measures may be applied for the sake of other Member States, this was not applied in the present study. The number of species in each pathway or combination would change if removing the species that are currently not likely to establish, and comments were added under specific pathways in section 4.

Agriculture-Escape: *Pueraria lobata*

Agriculture -Contaminant: *Alternanthera philoxeroides*, *Parthenium hysterophorus*

Aquaria-Escape: *Alternanthera philoxeroides*, *Eichhornia crassipes*

Ballast: *Alternanthera philoxeroides*, *Persicaria perfoliata*

Escapes: *Herpestres javanicus*, *Myocastor coypus*

Forestry-Contaminant: *Persicaria perfoliata*

Horticulture – Escape: *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Pueraria lobata*

Horticulture – Contaminant: *Alternanthera philoxeroides*, *Parthenium hysterophorus*, *Persicaria perfoliata*

Landscaping-Contaminant: *Persicaria perfoliata*

Medicinal-Escape *Persicaria perfoliata*

Other-Contaminant *Persicaria perfoliata*

Transport: *Herpestres javanicus*, *Parthenium hysterophorus*

3.6 Considerations of vectors

The vectors for each pathway may help better focus priority pathways. The vectors identified in this study as presented in Table 4. Some vectors in Madsen et al. (2014) did not apply to the species on the EU List. It should be recognized that information on vectors was missing for many pathways and this analysis is only partial. It nevertheless highlights vectors that are common to several species.

Pathway	Vector
Agriculture, horticulture, forestry, landscaping	plants
	plants with roots,
	plants with soil
	seeds
Forestry	bark, wood

Pathway	Vector
Agriculture	birdseeds
	fruit & veg., cut flowers
	grain
	hay
Angling-Contaminant	live bait
Aquaculture-	fish

Pathway	Vector
Contaminant	
Escapes	live food for consumption
	live bait
	pets
	private collections, public estates and parks
	zoo
Transport	airplane
	cars
	cattle
	containers
	leisure boat

Pathway	Vector
	livestock
	machinery
	ships
	trucks
	vehicles
	baggage
	shoes or clothes
Other contaminant	soil
	man-made goods
Other escape	release of fished individuals

Table 4. Vectors identified for different pathways

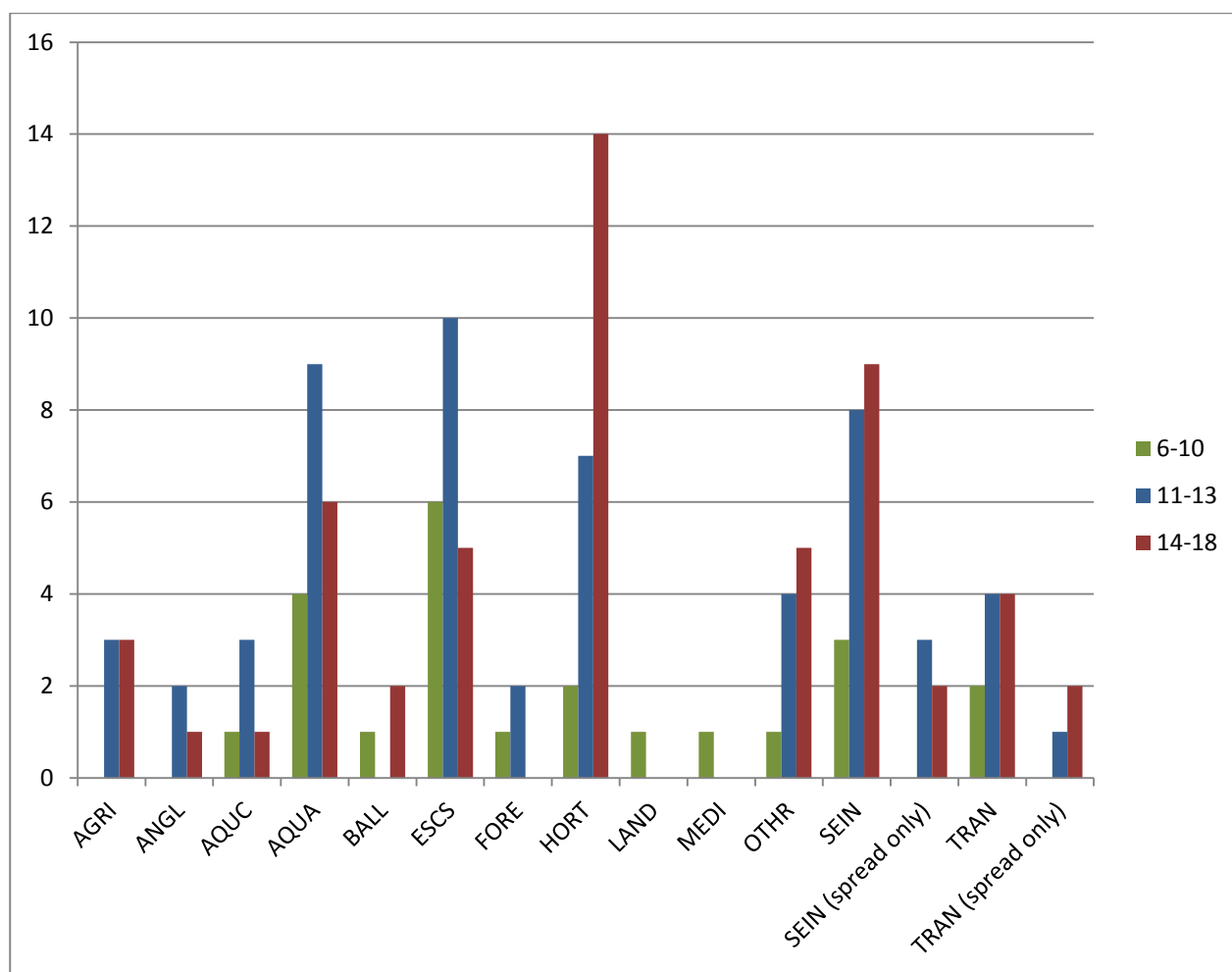


Fig. 9. Number of species in 3 categories (total impact score) for each Pathway (not taking account Mode of entry)

Analysis with combinations Pathway-Mode of entry and total impact scores

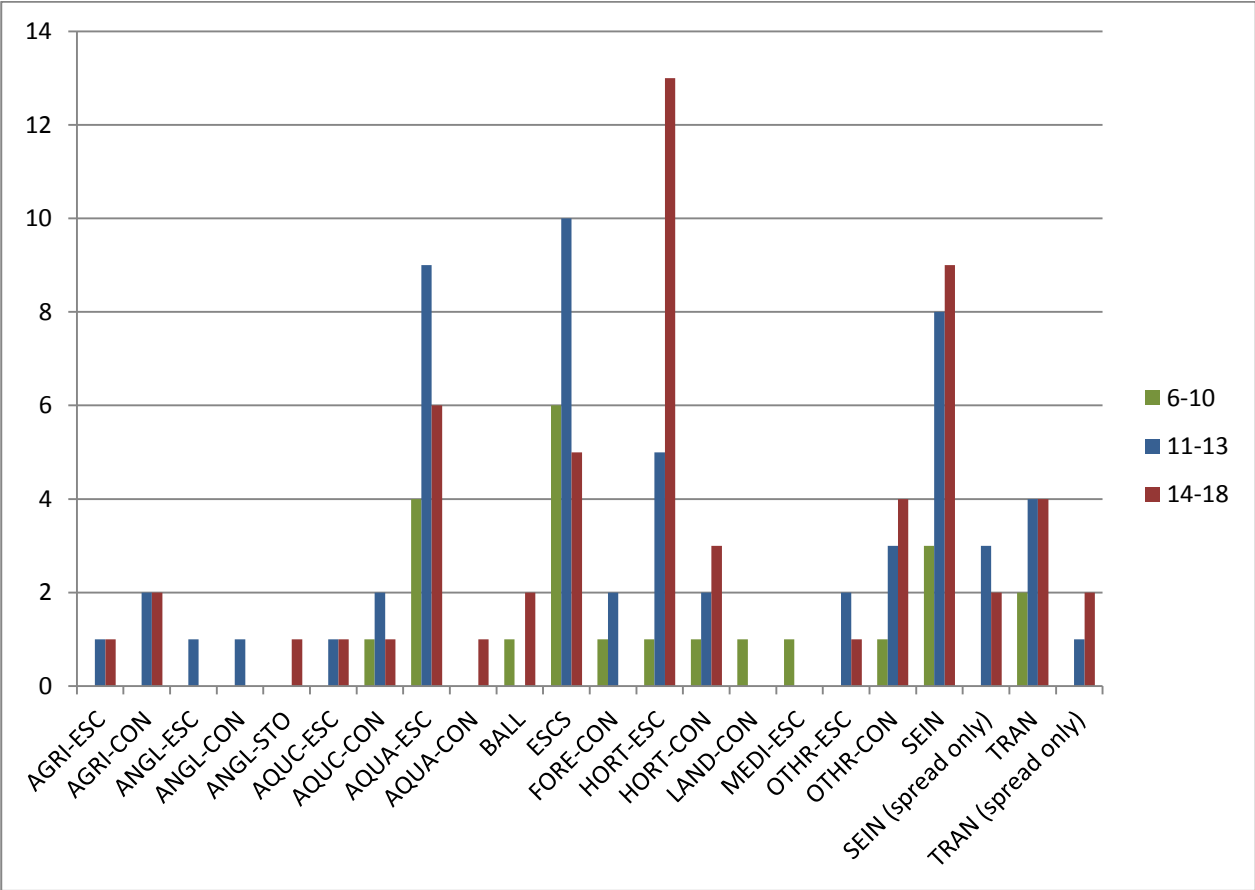


Fig. 10. Nb of species in 3 categories (total impact score) for combinations Pathway-Mode of entry

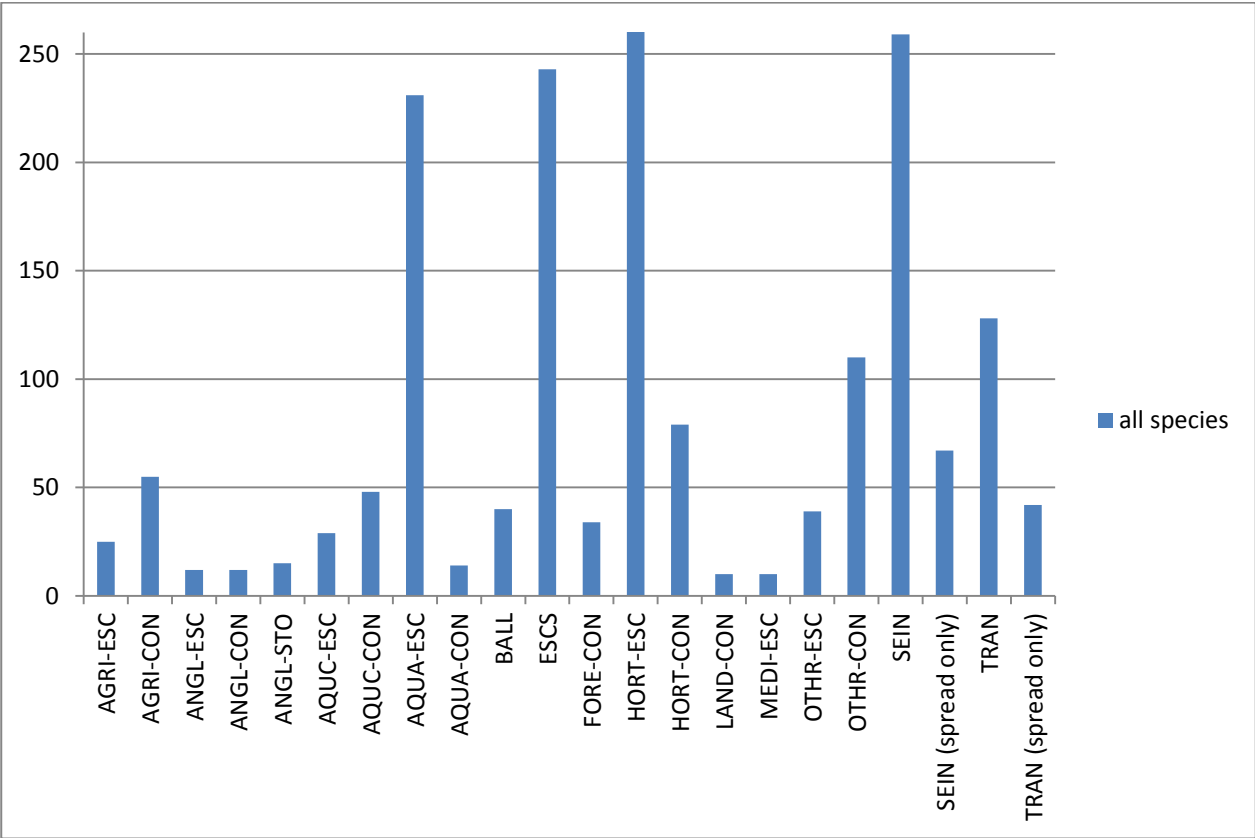


Fig. 11. Total impact score for all species under a combination Pathway-Mode of entry

Analysis with combinations Pathway-Mode of entry and biological impact scores

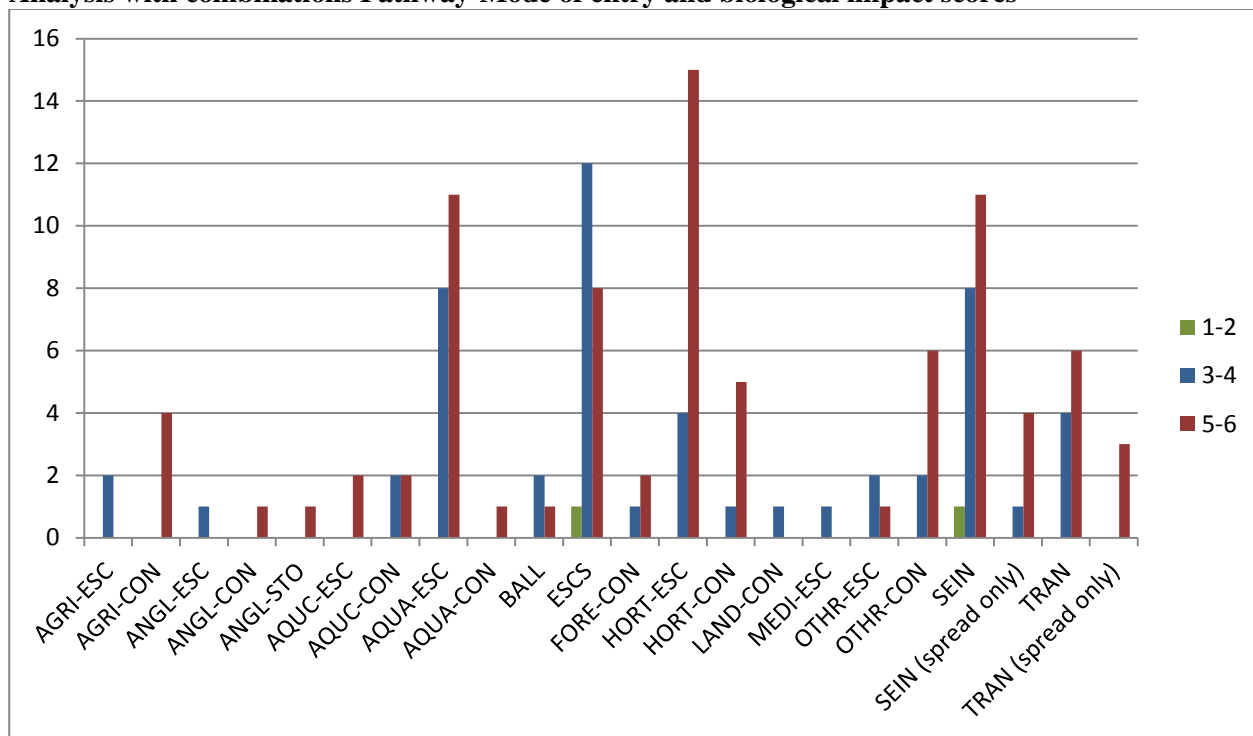


Fig. 12. Nb of species in 3 categories (of biological impact (sum of impact on native species and ecosystems)) for combinations Pathway-Mode of entry

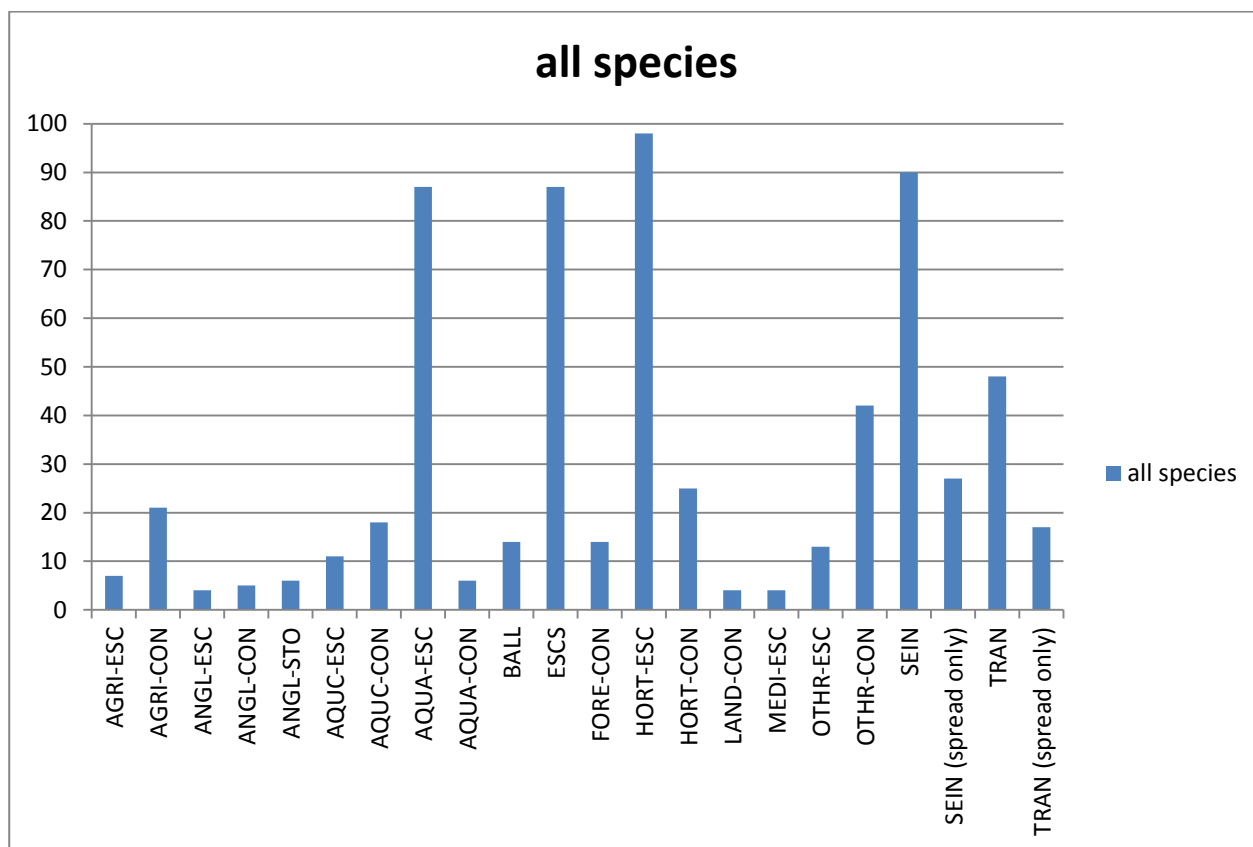


Fig. 13. Total biological impact score (sum of impact on native species and ecosystems) for all species under a combination Pathway-Mode of entry

4. Pathways and measures

Details on each pathway or combination pathway-mode of entry are given below, with:

- Species of the EU list
- Coverage
- Volume of the pathway
- Temporal changes
- Stakeholders
- Already in place in Denmark
- International guidance
- Countries for which information on measures was found
- Possible measures
- Reassessment of the priority group determined in section 3.4
- References.

When the text below mentions specific species, all literature references can be found in the complete spreadsheet. For each pathway or combination pathway-mode of entry, the vectors and species concerned are given. Vectors were considered separately if they may necessitate different measures. It should be noted that each vector probably applies to more species than identified.

Species that are already established in Denmark are mentioned with others in the description of pathways below. Further consideration may be needed as to whether measures on some introduction pathways are justified (e.g. taking account of how widespread the species is in Denmark).

Measures already applied in Denmark are sometimes mentioned, but this is not exhaustive. It is understood that the Ministry of Environment and Food already has the overview of measures applied in the country, and focus was given to international guidance and measures identified for other countries. Some of those may also already be applied in Denmark.

Regarding measures applied in other countries, the list is not exhaustive and not all EU countries were searched. Information arises from targeted Internet searches carried out in several languages (English, French, German, Spanish, Italian, Swedish, Norwegian). Not all countries or languages were searched for every pathway. The countries for which information was found are indicated. For any country, the list of measures and initiatives is not complete, but are examples, except when the country already has an action plan for the pathway (e.g. the UK for zoological gardens).

For some pathways, action plans have been developed in some countries or international guidance is available, which give a good overview of possible measures. For some other pathways, little information is available. It is expected that more experience of measures will become available as EU countries start developing and implementing action plans for their priority pathways.

Some general measures apply across all pathways, and belong to all countries' strategies on invasive alien species. They are not named in each case below, such as:

- promoting awareness of invasive alien species and the problems they may cause. Prohibition of species on the EU List may lead to import of others.
- surveillance and early detection systems.
- ensuring that appropriate reporting systems are in place so that the general public or stakeholders can report any sighting of invasive alien species, including of the species of the EU list, even if not currently established in Denmark.

All pathways were dealt with below, even briefly for those that did not have a high priority, because they may need to be addressed in the context of a wider strategy. Some pathways or combinations were not identified as priorities here, but may have a higher priority when looking at the overall risk of invasive alien species to Denmark.

This analysis does not cover intentional pathways, and neither illegal introduction of species on certain pathways. However, it does cover cases where introduction may be linked to a lack of knowledge, e.g. the general public not being aware of the prohibitions and restrictions applying to the species on the EU List.

The combinations of pathways, modes of entry and vectors are ordered below according to the pathways. The priority group refers to that defined in section 3.4.

4.1 Escapes (zoos, pets, public estates and parks, live food for consumption, live bait, botanical gardens, fur farms)

ESCAPES - ZOOS	
Species of the EU List. <i>Alopochen aegyptiaca</i> <i>Callosciurus erythraeus</i> <i>Lithobates catesbeiana</i> <i>Muntiacus reevesii</i> <i>Myocastor coypus</i> <i>Nasua nasua</i>	
	<i>Oxyura jamaicensis</i> <i>Procyon lotor</i> <i>Sciurus carolinensis</i> <i>Sciurus niger</i> <i>Threskiornis aethiopicus</i>
Coverage. In Denmark, facilities that display animals to the public for more than 7 days per year fall under the legislation on zoos (see below). There are currently 34 facilities registered as zoos in Denmark. In addition to zoos in the traditional sense, this includes wildlife parks, bird parks, leisure parks, aquaria, etc. Such facilities are registered with the Ministry of Agriculture and are subject to rules including on moving of animals between zoos, animal health and yearly controls. Notes: species that may be used in aquaria are listed under Aquaria-Escape, but could be covered by some of the guidance below.	
Volume of the pathway. Unknown, but presumably relatively few individuals of each species. Some species considered have been registered at some stage in Danish zoos (see spreadsheet), for example 11 <i>Nasua nasua</i> in Givskud zoo in 2011.	
Temporal changes. Individuals will progressively die and cannot be replaced or bred according to the EU regulation. <i>Herpestes javanicus</i> and <i>Myocastor coypus</i> are currently unlikely to establish, but this may change.	
Stakeholders <ul style="list-style-type: none"> Facilities registered as zoos (currently 34, list available here: https://www.foedevarestyrelsen.dk/_layouts/15/sdata/liste_til_netnet_zoologiske_anlaeg.pdf) Ministry of Agriculture, responsible for the implementation of the law on zoos (BEK nr 1397 af 02/12/2015) DAZA – Danish Association of Zoos and Aquaria (15 members) Municipalities in which the zoos are located General public (including schools as visitors to zoos) 	
Already in place in Denmark <i>Enclosure and rules against escapes.</i> According to § 12 of the law on zoos (BEK nr 1397 af 02/12/2015), the enclosures should be built so that animals cannot escape. In addition (§ 24) zoos should have procedures for the recapture of escaped animals, and should inform the Ministry of Agriculture on escaped animals; this should happen immediately for dangerous animals. It is not clear which stakeholders are involved in the case of escape, and what is done for animals that are not dangerous. There may be initiatives already conducted on invasive alien species generally (not searched).	
International guidance European Code of Practice for Zoos and Aquaria (Scalera et al., 2016). Guidelines of EAZA (2013) on zoo management and development.	
Countries for which information on measures was found UK: A Non-Native Species Pathway Action Plan for Zoos has been developed (nonnativespecies.org, 2018), as well as a Code of practice (based on the European one above). The Guidance for zoos of England and Wales (available from the same site) aims to “remind those keeping non-native species in licensed zoos in England and Wales of their responsibilities” to avoid the escape of non-native animals (In the UK, it is an offence to release or allow escape from captivity of any animal that is not ordinarily resident in the country or is listed on a certain schedule). Italy, Spain: initiatives by individual zoos (references below). Veterinary Associations. The World Small Animal Veterinary Association provides information on standards for microchipping (WSAVA, 2018), and the American Veterinary Medical Association describes the use of microchips for marking animals (AVMA, 2018).	
Possible measures	

From the European Code of Practice (Scalera et al., 2016) (main options were extracted excluding those relating to escapes, already covered):

- Training of staff on possible risks related to the escape of IAS.
- Removing potential IAS from open displays, e.g. displays without roofs, unless all possible measures to prevent their escape/release have been undertaken.
- Not allowing species that present a risk to move freely in the facility, or reducing the risk (e.g. releasing only males, restricting the ability of birds to fly).
- Strict monitoring and appropriate management measures to prevent accidental introduction of invasive species into the environment.
- Systems in place to minimise the risks of theft, malicious damage or release of animals by visitors or other non-authorised people.
- Regular emergency planning to reduce the risk of escape during catastrophic events such as extreme weather conditions, fire, flood or earthquake.
- Awareness raising and outreach (described in details in Scalera et al., 2016).
- Establishment and implementation of an early warning system aimed at informing promptly the competent authorities about each case of escape.
- Contingency plans in collaboration with relevant agencies, including clear information on the established chain of responsibility.
- All escapes recorded and relevant detailed reports made (e.g. to national or European authorities) and support specific and comprehensive analysis regarding IAS originated by escapes/releases from zoological gardens and aquaria in Europe.
- Consider registry and related marking scheme for all animals kept in captivity. In relation to this, the European Association for Zoos and Aquaria also recommends marking of animals, and microchips is the most commonly used method in European zoos (EAZA, 2013). More details on microchips are given in WSAVA (2018) and AVSA (2018). However, microchips cannot be used to locate an animal at distance (e.g. in case of escape), because a scanning device needs to be used to read the code. GPS systems for use on zoo animals (which could be used at distance but has the inconvenient of using external devices) have had a limited use so far in zoos; they are mostly used in the wild, but the technology is evolving and new solutions may become available (Whitham & Miller, 2016).
- Involving the public and relevant interest groups in monitoring activities, and implement targeted awareness-raising activities to increase the chances of early detection of new IAS.

UK (noninvasives.org, 2018)

The following measures mentioned in the action plan may apply to Denmark:

- Development of national Guidance and Code of practice.
- Distribution of the Guidance and Code of Practice (either sent or through visits) to zoos and to relevant associations (in UK, British Association of Leisure Parks, Piers and Attractions Limited (BALPPA) and the National Farm Attractions Network (NFAN)).
- Guidance circulated to local authorities (in UK, e.g. Environmental Health Officers).
- National associations (in UK, British Association of Zoos and Aquariums) cooperating to help raise the level of awareness (talks at meetings, publicizing guidance and Code of Practice online and in magazine as appropriate).
- Guidance circulated to zoo inspectors, and more extensive guidance developed on exhibits contravening the rules for enclosure (e.g. free flying birds), making explicit that certain requirements apply to non-native animals as well as those that pose a risk to public safety.
- Zoo inspectors requested to report all incidences of exhibits with animals that have uncontrolled access outside the zoo.
- Setting up a group to review the recording of escapes by zoos and make recommendations on ways in which this information might be reported and collated centrally.
- Develop measures and guidelines against infractions.
- Maintaining a reporting line for escapes for species capable of becoming established.
- Making greater use of zoos to help raise public awareness of the issue of invasive species among their visitors.
- Rapid response working group assessing what knowledge, expertise and resources exist to deal with establishing populations of escaped zoo animals.

Italy (UIZA, 2018). Awareness. Education campaigns carried out in zoos through activities, laboratories, posters, brochures.

<p>Spain:</p> <p>Awareness. Laboratory on invasive species activity for school classes at the Barcelona zoo (https://www.zoobarcelona.cat/index.php/es/taller-especies-invasoras).</p> <p>Awareness. Activity brochure with games for kids (http://vigozoo.com/wp-content/uploads/2018/02/Accion-03-Especies-ex%C3%B3ticas-invasoras.pdf).</p> <p>Addressing the problematic of increasing numbers of animals delivered to zoos by the public (Cuadrado et al., no date).</p>
<p>Reassessment of priority. Unchanged, High (Group A).</p>
<p>References</p> <p>AVMA. 2018. Microchipping of Animals. https://www.avma.org/KB/Resources/Reference/Pages/Microchipping-of-Animals-Backgrounder.aspx</p> <p>Cuadrado M.; Sánchez I.; Quevedo M.A., Flores L. No date. ¿Qué hacer con los ejemplares de especies exóticas entregados por particulares?: Nuestra experiencia en el ZooBotánico de Jerez. ZooBotánico de Jerez.</p> <p>EAZA. 2013. The Modern Zoo: Foundations for Management and development. 2nd edition. The European Association for Zoos and Aquaria, Executive Office Amsterdam, the Netherlands.</p> <p>Nonnativespecies.org. 2018. Pathway Action Plans (incl. Links to Zoos Pathway Action Plan, GB Zoos Code of Practice, England and Wales Guidance for Zoos. http://www.nonnativespecies.org/index.cfm?sectionid=135</p> <p>Scalera R., Genovesi P., de Man D., Klausen B., Dickie L. 2016. European Code of Conduct. On Zoological Gardens and Aquaria and Invasive Alien Species. Report prepared by Council of Europe, November 2016. https://rm.coe.int/16806c0687.</p> <p>UIZA. 2018. https://uiza.org/informazioni/occhio-allalieno/</p> <p>Whitham J.C., Miller L.J. 2016. Using technology to monitor and improve zoo animal welfare. Animal Welfare 2016, 25: 395-409.</p> <p>WSAVA. 2018. Microchip Identification Guidelines. https://www.wsava.org/Guidelines/Microchip-Identification-Guidelines.</p>

ESCAPES - PETS																	
<p>Species of the EU List.</p> <table> <tr> <td><i>Alopochen aegyptiaca</i></td><td><i>Oxyura jamaicensis</i></td></tr> <tr> <td><i>Callosciurus erythraeus</i></td><td><i>Pseudorasbora parva</i></td></tr> <tr> <td><i>Herpestres javanicus</i></td><td><i>Procyon lotor</i></td></tr> <tr> <td><i>Lithobates catesbeiana</i></td><td><i>Sciurus carolinensis</i></td></tr> <tr> <td><i>Muntiacus reevesii</i></td><td><i>Sciurus niger</i></td></tr> <tr> <td><i>Nasua nasua</i></td><td><i>Tamias sibiricus</i></td></tr> <tr> <td><i>Nyctereutes procyonoides</i></td><td><i>Threskiornis aethiopicus</i></td></tr> <tr> <td><i>Ondatra zibethicus</i></td><td><i>Trachemys scripta</i> (all 3 subspecies)</td></tr> </table>		<i>Alopochen aegyptiaca</i>	<i>Oxyura jamaicensis</i>	<i>Callosciurus erythraeus</i>	<i>Pseudorasbora parva</i>	<i>Herpestres javanicus</i>	<i>Procyon lotor</i>	<i>Lithobates catesbeiana</i>	<i>Sciurus carolinensis</i>	<i>Muntiacus reevesii</i>	<i>Sciurus niger</i>	<i>Nasua nasua</i>	<i>Tamias sibiricus</i>	<i>Nyctereutes procyonoides</i>	<i>Threskiornis aethiopicus</i>	<i>Ondatra zibethicus</i>	<i>Trachemys scripta</i> (all 3 subspecies)
<i>Alopochen aegyptiaca</i>	<i>Oxyura jamaicensis</i>																
<i>Callosciurus erythraeus</i>	<i>Pseudorasbora parva</i>																
<i>Herpestres javanicus</i>	<i>Procyon lotor</i>																
<i>Lithobates catesbeiana</i>	<i>Sciurus carolinensis</i>																
<i>Muntiacus reevesii</i>	<i>Sciurus niger</i>																
<i>Nasua nasua</i>	<i>Tamias sibiricus</i>																
<i>Nyctereutes procyonoides</i>	<i>Threskiornis aethiopicus</i>																
<i>Ondatra zibethicus</i>	<i>Trachemys scripta</i> (all 3 subspecies)																
<p>Coverage. This covers animals owned by the general public, and also private collections of animals (such as birds – identified in the EU risk assessments for <i>Alopochen aegyptiaca</i> and <i>Threskiornis aethiopicus</i>). It may also include facilities that are not subject to the same legislation as zoos (e.g. because they are open less than 7 days per year).</p> <p>Escape may arise due to ‘true’ escape (animal running away) or release/disposal in nature (when the pet has become too big, too many or is not wanted anymore, instead of killing it or with the aim of improving its living conditions). Although the latter case is considered as a release in some risk assessments, it is still an escape from captivity, and is covered by the same measures.</p> <p>Escapes from aquaria are covered separately. However, the list above contains two aquatic animals, <i>Lithobates catesbeiana</i> and <i>Pseudorasbora parva</i>, because of their use in garden ponds.</p>																	
<p>Volume of the pathway. Unknown. However, the turtles <i>Trachemys scripta</i> are popular pests and frequently released in nature by their owners. <i>Nasua nasua</i> is mentioned by one source as a popular ‘alternative’ pet in Denmark (although it is prohibited since 2015, with exceptions). Some individuals of the species of the EU List were delivered to recognized facilities when the implementation of the EU Regulation started (e.g. <i>Muntiacus reevesii</i>) and more are probably still with private owners. The frog <i>Lithobates catesbeiana</i> is used in garden ponds, presumably often without enclosure, and escape would be facilitated. Similarly, the fish <i>Pseudorasbora parva</i> may escape ponds during for example cleaning activities or flooding. Some species were considered as pets because this was mentioned in the EU risk assessment, but no data was available on whether they are used as pets in Denmark (for example, <i>Ondatra zibethicus</i>).</p>																	

<p>Temporal changes. As breeding and sale of the species is now banned, the numbers should decrease as individuals die. However, not all owners may be aware of the new rules (esp. relating to breeding). Some species have a long lifetime, such as <i>Trachemys scripta</i>.</p>
<p>Stakeholders</p> <ul style="list-style-type: none"> • Pet owners • Pet trade (importers, breeders, retailers), including of material (cages, food etc.) • Associations of pet owners, as well as specialized websites and magazines • Associations of pet trade: e.g. Dyrehandlernes brancheforening • Possibly veterinarians • Naturalist associations (e.g. Danske Ornitologisk Forening – DOF), hunters associations, and reporting systems (including through Miljøstyrelsen, municipalities, DOF) • Facilities registered to receive species of the EU List
<p>Already in place in Denmark</p> <ul style="list-style-type: none"> • Prohibition to release animals that do not naturally occur in Denmark into nature without authorisation (Naturbeskyttelseslovens § 31, stk.1 lbkg nr. 85/2002). • For some species: <i>Nyctereutes procyonoides</i> individuals should be registered and marked, and any escape should be notified. The species is subject to an extensive control programme. <i>Ondatra zibethica</i> can be hunted all-year round and is covered by the ‘Bekendtgørelse om vildtskader’. • Information campaigns have been conducted around invasive species in the media. A campaign to deliver individuals at registered facilities has led to the recovery of a number of individuals since 2016 (e.g. 5 <i>Muntiacus reevesii</i>, 1 <i>Callosciurus erythraeus</i>). • The “Wanted” (Eftersøgt) campaign, targeting hunters, covered some of the species. • Guidelines for persons trading species are available on Miljøstyrelsen’s site (incl. on invasive species, the ban of species on the EU List, and the need to inform clients (‘Sådan undgår du at sælge invasive arter’, March 2018). • Brochure on not releasing pets into nature (in preparation).
<p>International guidance. European Code of Conduct on Pets and Invasive Species (Davenport & Collins, 2016).</p>
<p>Countries for which information was found</p> <p>Italy: owners should register their pets (of the EU List) with the Ministry of Environment before 31 August 2019 (form, with copy of identity documents). Owners should ensure that their pets cannot escape and do not reproduce (Ministero dell’Ambiente, 2018).</p> <p>France: The legislation on wild fauna in captivity was recently amended (Legifrance, 2018), but no information was found on how it is going to be implemented for people who already own species on the EU List. Nevertheless, species of the EU List are among those needing registration in a national database. Individuals of some species should be marked (radiofrequency transponder (microchip), tattoo or ring depending on species; i-fap, 2018). Infraction to the rules on non-domestic animals may lead to up to 6 months jail and 9000 € fines (Ministère de l’Environnement, 2018). The control plan implemented against <i>Callosciurus erythraeus</i> in Alpes-Maritimes (South of France) is detailed in Chapuis et al. (2011). Other action plans are probably available from various countries on individual species.</p> <p>Spain and Portugal. The project LIFE Trachemys, on eradication, included a component aiming at deterring people from release exotic turtles into nature.</p> <p>Sweden. Recommendations at www.naturvardsverket.se (especially on not releasing pets and aquaria in nature).</p> <p>Belgium. Issues related to invasive squirrels (ppt, Schockert et al., 2016) and brochures for hunters (Wallonie, no date).</p> <p>Ireland. Proactive information and questions to potential pet owners: https://invasivespeciesireland.com/what-can-i-do/pets/guidance-for-pet-owners/</p> <p>Veterinary Associations. The World Small Animal Veterinary Association provides information on standards for microchipping (WSAVA, 2018), and the American Veterinary Medical Association describes the use of microchips for marking animals (AVMA, 2018).</p>
<p>Possible measures</p> <ul style="list-style-type: none"> • The European Code of Conduct recommends promoting awareness of IAS and the problems they may cause, promoting the message that members of the public should never deliberately release pets, Promoting awareness among owners that releasing pets is often cruel, encouraging pet trade to provide

detailed information on the animals they sell (e.g. size, etc.), so that buyers make an informed choice (this does not apply to the species currently on the list, as sale is banned).

- For facilities that hold animals but are not subject to the same legislation as zoos (e.g. because they are open less than 7 days per day), some measures recommended for zoos may be relevant.
- Inform that pets should not be released, and reasons (including that it is illegal).
- Recommendation to not release pets into nature (Sweden, Naturvårdsverket, 2018).
- Outreach to public through pet retailers, pet-related trade, veterinarians, possibly also public places (libraries, municipalities).
- Compulsory marking and registration of individuals (as already required in Denmark for *Nyctereutes procyonoides* by chip, or in other countries with various methods). The marking method needs to be adapted to the species (e.g. as in France). GPS-collars are commercially available for some pets (esp. dogs and cats), with the primary aim of finding lost animals. It was not found if they are used for other species. They may allow tracking accidental escapees. References on microchips are given under Escapes-zoos.
- Registration of species on the EU List held as pets (as in Italy, possibly France).
- Measures for recovery or hunting of escaped individuals (as applied for some species).
- Campaigns for delivery of individuals to recognized facilities. No information was found on the effectiveness of such measures: pet owners have invested affection, money and time in their pets and are likely to require strong arguments to deliver them voluntarily.
- Most animals covered are easy to recognize and may be detected early. The general public, and especially nature-interested persons have a role in early detection (Paquet, 2016, presenting system for Wallonie, Belgium). However, specific issues may arise. For example, convincing the public that some subgroups need to be eliminated is more difficult and requires communication. In particular squirrels may at first, before damage starts to occur, be well accepted by the public (cute animals, not shy, easy to observe – Chapuis et al., 2011; Schockert, 2016, Paquet, 2016). The EU risk assessment for *Sciurus carolinensis* noted possible social conflict on eradication programmes. A study in the UK showed that the need for measures on the grey squirrel was better accepted after providing information on the species, its invasiveness and impacts (Novoa et al., 2017).
- Questions to potential pet owners such as in InvasiveSpeciesIreland (2018) may be useful for current owners, to realize that they may not be able to keep their pet at term, and would benefit from delivering them to a recognized facility.

Reassessment of priority. Unchanged, High (Group A)

References

- Chapuis J.-L., Dozières A., Pisanu B., Gerriet O., Berlin S., Pauvert S. 2011. Plan national de lutte relatif à l'écureuil à ventre rouge (*Callosciurus erythraeus*) dans les Alpes-Maritimes.
<https://ecureuils.mnhn.fr/sites/default/files/documents/plan-national-lutte-ecureuil-ventre-rouge.pdf>
- Davenport K., Collins J. 2016. European code of conduct. Pets and invasive alien species. Council of Europe, February 2016.
- i-fap. 2018. Identification de la faune sauvage protégée. <https://www.i-fap.fr/espace-grand-public>
- InvasiveSpeciesIreland. 2018. <https://invasivespeciesireland.com/what-can-i-do/pets/guidance-for-pet-owners/>
- Legifrance. 2018. Arrêté du 8 octobre 2018 fixant les règles générales de détention d'animaux d'espèces non domestiques. NOR: TREL1806374A. Version consolidée au 13 novembre 2018.
- LIFE Trachemys.
http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3821
- Ministero dell'Ambiente. 2018. In Vigore Il Decreto Sulle Specie Esotiche Invasive.
<http://www.minambiente.it/notizie/vigore-il-decreto-sulle-specie-esotiche-invasive>
- Naturvårdsverket. 2018. <https://www.naturvardsverket.se/Var-natur/Djur-och-vaxter/Invasiva-frammande-arter/>
- Novoa A., Dehnen-Schmutz K., Fried J., Vimercati G. 2017. Does public awareness increase support for invasive species management? Promising evidence across taxa and landscape types. Biological Invasions. DOI: 10.1007/s10530-017-1592-0.
- Paquet J-Y. 2016. Le rôle des naturalistes en matière de détection. Colloque: Les espèces exotiques envahissantes, un nouveau défi pour la Wallonie et pour l'Europe. 17 octobre 2016, Namur.
- Schockert V. 2016. Les écureuils exotiques. Situation et menaces à l'échelle européenne. Colloque: Les

espèces exotiques envahissantes, un nouveau défi pour la Wallonie et pour l'Europe. 17 octobre 2016, Namur Université de Liège. <http://biodiversite.wallonie.be/servlet/Repository/15h10-vinciane-schockert-ecureuils-exotiques.pdf?ID=35829&saveFile=true>

ESCAPES - PUBLIC ESTATES AND PARKS
Species on the EU List. <i>Alopochen aegyptiaca</i>
Coverage. This pathway related to the introduction of <i>Alopochen aegyptiaca</i> into public estates and parks in the Netherlands and the UK and their subsequent escape into natural areas (EU risk assessment). It is not clear how this applies to Denmark, nor if any other species of the EU List have been released in such settings prior to the implementation of the EU Regulation.
Volume of the pathway. The only species identified was <i>Alopochen aegyptiaca</i> , which is already established in Denmark.
Temporal changes. -
Stakeholders. Municipalities, Authorities managing public estates and parks.
Already in place in Denmark. <i>A. aegyptiaca</i> is covered by the law ' bekendtgørelse om vildtskader ' (BEK nr 971 af 27/06/2018), which provides that it can be hunted all-year round.
International guidance. Not searched.
Countries for which information was found. Not searched.
Possible measures <ul style="list-style-type: none"> Identifying whether <i>A. aegyptiaca</i> is present in public estates and parks in Denmark. The species can already be hunted all year-round.
Reassessment of priority. Insufficient elements to rate this combination.
ESCAPES - LIVE FOOD FOR CONSUMPTION
Species on the EU List. Animals: <i>Eriocheir sinensis</i> , <i>Procambarus clarkii</i>
Coverage. This covers aquatic species that may have been imported for food purposes (import is now forbidden) and released into the wild.
Volume of the pathway. Unknown. Only two species, <i>Eriocheir sinensis</i> , <i>Procambarus clarkii</i> . No indication was found if these species are held for food purposes. In addition, <i>Pacifastacus leniusculus</i> is subject to special rules (see below). In any cases, according to the EU regulation, import or breeding is prohibited.
Temporal changes. <i>Procambarus clarkii</i> is currently not at risk of establishment, and <i>Eriocheir sinensis</i> has been observed in Denmark but does not reproduce in current conditions (supposedly temperature and salt content).
Stakeholders <ul style="list-style-type: none"> Restaurants Dansk Amatørfiskerforening General public, especially fishermen
Already in place in Denmark <ul style="list-style-type: none"> The guidelines 'Vejl. om regler for udsætning af fisk, krebs og bløddyr i de ferske vande' prohibits release of crustaceans in freshwater. Temporary rules for commercial use of <i>Pacifastacus leniusculus</i> have been put in place in 2018 (MST, 2018).
International guidance. Not searched.
Countries for which information was found. Not searched.
Possible measures <ul style="list-style-type: none"> Informing restaurants likely to serve such food of the current EU and Danish Regulation and on invasive alien species generally. Public awareness (restaurant clients) on invasive alien species. Public awareness, also through relevant associations, so that escaped individuals may be found and disposed of.
Reassessment of priority. Decrease to Very Low (Group D) due to the species associated (only two, and not both having major impact).
References MST. 2018. https://mst.dk/natur-vand/natur/national-naturbeskyttelse/invasive-arter/hvad-goer-

myndighederne/love-og-regler/eu-forordningen/salg-af-signalkrebs/
ESCAPES - LIVE BAIT
Species on the EU List. Animals: <i>Orconectes limosus</i> , <i>Pseudorasbora parva</i>
Coverage. This covers species that may be released as bait by recreational anglers. This pathway can be considered together with the pathway Angling.
Volume of the pathway. Unknown. Only two species, <i>Orconectes limosus</i> , <i>Pseudorasbora parva</i> .
Temporal changes. -
Stakeholders. See Angling.
Already in place in Denmark. The guidelines 'Vejl. om regler for udsætning af fisk, krebs og bløddyr i de ferske vande' prohibits release of fish and crustacean in freshwater.
International guidance. see Angling.
Countries for which information was found. Not searched.
Possible measures. See Angling.
Reassessment of priority. Covered with the pathway Angling.
Reference -
ESCAPES - BOTANICAL GARDENS
Coverage. This pathway covers escapes of plants or animals from botanical gardens. It was not mentioned specifically in any EU risk assessment. However, some of the animals or plants may be in botanical gardens, and may escape. Escape of plants from other settings are covered in particular under Horticulture-Escape and Aquaria-Escape, and of animals under zoos and pets.
Volume of the pathway. This is not considered in details here, because this vector was not identified for any species on the EU List. However, it may nevertheless apply to some. Botanical gardens were identified early as a source of introduction of invasive alien plants (Heywood and Sharrock, 2013, citing sources), and were the subject of one of the first European Code of Conduct on Invasive Alien Species (Heywood and Sharrock, 2013). Some animals in the EU List may be present in botanical gardens.
Temporal changes. The species on the EU List cannot be imported, exchanged or bred, but some species may remain in botanical gardens for a while, unless actively eliminated.
Stakeholders <ul style="list-style-type: none"> • Botanical gardens • General public, incl. botanic associations
Already in place in Denmark. Not searched.
International guidance. European Code of Conduct for Botanic Gardens on Invasive Alien Species (Heywood & Sharrock, 2013).
Countries for which information was found. Not searched.
Possible measures <ul style="list-style-type: none"> • The European Code of Conduct covers awareness, information sharing, preventing new invasions, control measures (including removal of invasive plants as soon as detected), outreach, forward planning. • Awareness and information sharing with botanical gardens would also apply to animals. • Public-awareness and reporting systems would also trigger the public to report occurrences outside botanical gardens. • It was not found if any EU country has requested botanical gardens to remove from their collections the plants of the EU List (or animals present in their grounds), or to take actions to prevent their escape. No information on the handling or permits for holding invasive alien plants was found on the sites of Aarhus and Copenhagen botanical gardens.
Reassessment of priority. Not assessed here as no species specifically identified.
References Heywood V.H., Sharrock S. 2013. European Code of Conduct for Botanic Gardens on Invasive Alien Species. Council of Europe, Strasbourg, Botanic Gardens Conservation International, Richmond.

ESCAPES - FUR FARMS
Coverage. This pathway-vector combination was not considered relevant for Denmark for any species on the EU List (although the pathway was mentioned in several EU risk assessments), because the animals concerned are not used for fur-farming in Denmark. The use of some species for fur-farms had also been forbidden before the implementation of EU Regulation. There was one reported case of illegal presence of <i>Nyctereutes procyonoides</i> in a farm in 2015. This vector is briefly addressed below.
Volume of the pathway. Nil, except if illegal individuals.
Temporal changes. The importance of this pathway for Denmark would change if some of the species farmed for fur in Denmark were added to the EU List. Similarly, it would change if some species currently on the EU List were allowed for fur-farming again in the future (however, this is unlikely).
Stakeholders. Fur-farmers and their associations
Already in place in Denmark. Some species are covered by the law 'bekendtgørelse om vildtskader' (BEK nr 971 af 27/06/2018), which provides that they can be hunted all-year round.
International guidance. Not searched.
Countries for which information was found. Not searched.
Possible measures <ul style="list-style-type: none"> • Awareness-raising of fur-farmers, also through relevant associations, of the EU Regulation. • Measures against escapes and control of any escapee (see measures under Secondary introduction).
Reassessment of priority. Not assessed, as no species specifically identified.

4.2 Horticulture (escape, contaminant)

HORTICULTURE - CONTAMINANT
Species of the EU List <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> Terrestrial plants <i>Microstegium vimineum</i> <i>Parthenium hysterophorus</i> <i>Persicaria perfoliata</i> </div> <div style="width: 45%;"> Aquatic plants <i>Alternanthera philoxeroides</i> <i>Hydrocotyle ranunculoides</i> </div> </div> Animal <i>Vespa velutina</i>
Coverage. This pathway applied to five plants of the EU List that may be introduced as contaminant of other plants imported intentionally for horticultural purposes (e.g. gardens or ponds). The vectors identified were plants (including with roots and with associated soil/growing media). Terrestrial species could contaminate consignments of other plants as plants, but they may more commonly be associated as seeds (mentioned for some species such as <i>Persicaria perfoliata</i>). In addition, <i>Vespa velutina</i> may contaminate soil associated with plants for planting (as hibernating inseminated queens, or nests in the ground).
Volume of the pathway. There is a large trade of plants imported for horticultural purposes. The PRA on <i>Vespa velutina</i> considers that this is a less important pathway as hibernation in soil is comparatively rare, and nests are unlikely to not be detected (as wasps would respond aggressively to disturbance).
Temporal changes. At the moment, only <i>Hydrocotyle ranunculoides</i> , <i>Microstegium vimineum</i> , <i>Pennisetum setaceum</i> (the latter only in case of mild winters) and <i>Vespa velutina</i> may establish.
Stakeholders <ul style="list-style-type: none"> • Other authorities (phytosanitary authority – Landbrugstyrelsen, Customs) • Garden and pond owners, and their clubs and associations (e.g. Haveselskabet) • Professionals such as: gardeners, nurseries, gardens centers, aquaria shops and retailers (selling aquatic plants that may also be used outdoors), and their associations (e.g. Dansk Gartneri) • Specialized websites and magazines • General public, naturalist organisations • Reporting systems (including Miljøstyrelsen, municipalities) • For <i>Vespa velutina</i>, beekeepers, their associations and authorities (Landbrugstyrelsen) • For aquatic plants, possibly also anglers and people using leisure boats
Already in place in Denmark <ul style="list-style-type: none"> • Although invasive plants are not covered by the EU plant health legislation (incl. new EU Regulation 2016/2031 due to substitute EU Directive EU 2000/29 and associated regulations), various existing

phytosanitary requirements may to some extent limit the association of the plants concerned as contaminant for consignments from outside the EU (such as specific requirements relating to soil and growing media associated with plants – with replacement or treatment); however, these requirements do not apply to all third countries, and there are no such requirements within the EU. Plants for planting would also be inspected for phytosanitary reasons at import and during production in Denmark, and contaminating plants may be noticed (although not as seeds). Within the EU, the plant passport system with authorized producers would put certain requirements on the presence of plant pests (but not specifically invasive plants as contaminants).

- The awareness campaigns already in place may improve early detection.

International guidance

EPPO. 2009. Standard PP 3/74(1) 'EPPO guidelines on the development of a code of conduct on horticulture and invasive alien plants'. <https://www.eppo.int>

ISPM 36. 2012. International Standard for Phytosanitary Measures. *Integrated measures for plants for planting*. Rome, IPPC, FAO.

ISPM 40. 2017. International Standard for Phytosanitary Measures. *International movement of growing media in association with plants for planting*. Rome, IPPC, FAO. Available at <https://www.ippc.int>.

EPPO PRAs for invasive plants identify measures that may be required to address specific pathways of introduction, including unintentional ones such as contamination. They provide that a phytosanitary certificate (PC) delivered by the exporting country attests that the requirements have been fulfilled. However, invasive plants are specifically excluded from the new EU phytosanitary regulation (2016/2031 of 26 Oct. 2016), do not fall under phytosanitary legislation in EU countries, and are therefore not covered by phytosanitary certificates. Implementing the measures recommended in EPPO PRAs would require that the EU regulation is amended or a parallel regulation using similar requirements and 'certificates'/ 'plant passports' is developed for invasive alien species as contaminants (and covering imports from within the EU and from third countries).

Countries for which information on measures was found

UK. The Invasive Non-Native Species Strategic Communications Plan for Great Britain provides for a general communication strategy that would apply to many pathways.

Ireland and Northern Ireland. A Horticulture Code of Good Practice (Kelly, 2012) covers contamination (among other issues) and targets plant producers, nurseries, wholesalers, garden centres and retailers of plants, as well as landscapers, landscape architects, local authorities and those with responsibilities for parks, properties and land.

Possible measures

- For plants, EPPO PRAs identify measures that may be required and attested in a phytosanitary certificate. Specific requirements are defined in each PRA, such as:
 - Confirmation of pest-free production from country of origin, with surveillance and monitoring methods that should be specified by the exporting country (EPPO, 2016a – PRA for *Microstegium vimineum*).
 - Pest-free area, or pest-free place of production/production site (combining measures: visual inspection at the place of production, specified treatment, growing in glasshouses and in sterilized soil, internal surveillance and/or eradication or containment campaign) or certification scheme for plants for planting, or removal of the growing medium from plants for planting (EPPO, 2014 – PRA for *Parthenium hysterophorus*).
 - Pest-free place of production, or pest-free place of production and appropriate buffer zone (as the plant may be spread by waters and birds), or pest-free area, or plants grown in containers with sterilized growing medium, or plants free from growing media (EPPO, 2007 – PRA for *Persicaria perfoliata*).
 - Certification scheme for pest free production from country of origin. Data requirements for surveillance and monitoring to be provided by the exporting country should be specified (EPPO, 2016b - EPPO Pest Risk Analysis for *Alternanthera philoxeroides*).
 - Inspection at points of entry (i.e. at import). Awareness-raising and training of border staff on the species with identification guides at point of entry (EPPO 2016b, also applying to other species). Inspection at points of entry may need the involvement of the plant health authority and its phytosanitary inspectors.
- Guidance to nurseries and garden centres in relation to contaminating plants (although the plant consignments may remain for periods too short to allow for the emergence of the associated invasive plants).
- Awareness-raising targeting private and professional gardeners on the specific species that may be associated with the plants they buy, and encouraging removal and reporting of such plants if they emerge.

<ul style="list-style-type: none"> • Awareness campaigns for beekeepers and relevant stakeholders in relation to <i>Vespa velutina</i>. WGIAS (2017) proposes that honey producers adopt sustainability policies including surveillance, and receive industry accreditation for that. • For aquatic plants, the involvement of anglers, boaters and water leisure trade would be useful (for reporting and as cleaning of their material is indispensable) (EPPO, 2016b – PRA for <i>Alternanthera philoxeroides</i>). Online and printed advice may be necessary for the horticultural industry (EU risk assessment on <i>Hydrocotyle ranunculoides</i>). • <i>Vespa velutina</i>. Inspection of plants for planting at import may detect individuals (see above). Detection is more likely to occur when the wasp has emerged from the soil. It may be possible to design similar requirements as for quarantine pests, such as pest-free area, or production under specific conditions, or soil requirements etc. However, such requirements may not be feasible given the large range of plants for planting involved. Defining requirements and their applicability would require a detailed study on risk management options for Denmark.
Reassessment of priority. Unchanged, Medium (Group B)
References EPPO. 2007. EPPO Pest risk analysis for <i>Polygonum perfoliatum</i> . 07-13387. Available from https://www.eppo.int EPPO. 2014. EPPO Report of a Pest Risk Analysis for <i>Parthenium hysterophorus</i> . 14-19988. Available from https://www.eppo.int EPPO. 2016a. EPPO pest risk analysis for <i>Microstegium vimineum</i> . 16-21488. EPPO, Paris, France. Available from https://www.eppo.int EPPO. 2016b. EPPO Pest Risk Analysis for <i>Alternanthera philoxeroides</i> . 16-21485. Available from https://www.eppo.int Kelly J. 2012. Horticulture code of good practice to prevent the introduction and spread of invasive non-native species. V2.0. Prepared as part of Invasive Species Ireland. Non-native Species. 2018. The Invasive Non-Native Species Strategic Communications Plan for Great Britain. http://www.nonnativespecies.org/downloadDocument.cfm?id=272 WGIAS. 2017. Working Group on Invasive Alien Species. Surveillance of Invasive Alien Species of Union concern.

HORTICULTURE-ESCAPE	
Species of the EU List <div> <div> Aquatic species <i>Alternanthera philoxeroides</i> <i>Cabomba caroliniana</i> <i>Eichhornia crassipes</i> <i>Elodea nuttallii</i> <i>Hydrocotyle ranunculoides</i> <i>Lagarosiphon major</i> <i>Ludwigia grandiflora</i> <i>Ludwigia peploides</i> <i>Myriophyllum aquaticum</i> <i>Myriophyllum heterophyllum</i> </div> <div> Terrestrial species <i>Asclepias syriaca</i> <i>Baccharis halimifolia</i> <i>Gunnera tinctoria</i> <i>Heracleum mantegazzianum</i> <i>Heracleum persicum</i> <i>Impatiens glandulifera</i> <i>Lysichiton americanus</i> <i>Pueraria lobata</i> </div> </div>	
Coverage. The pathway covers escape into nature of plants that have been intentionally imported for use in horticulture, i.e. mainly gardens, including garden ponds, and private collections. Escapes may happen by natural means (e.g. by seeds or vegetative propagation, escape with flood water) or be human-assisted (improper disposal of garden waste, as plant parts or pond water, into nature during gardening/pond cleaning or maintenance, leading to escape). Although spread through garden waste is mentioned specifically only in few EU risk assessments, it is likely to be relevant for more species on the EU List. Escapes of animal species held in garden ponds are covered under Escape-Pets. Escapes from Aquaria, Agriculture and Forestry are covered separately.	
Volume of the pathway. Potentially high. The list contains ornamental plants that have been widely used, and may still be present in gardens and ponds.	
Temporal changes. Sale and exchange of the plants on the EU List is banned. However, temporal changes will depend also on whether gardeners are aware that they should not exchange or give away these plants anymore.	

<p>Stakeholders</p> <ul style="list-style-type: none"> • Garden and pond owners, and their clubs and associations (e.g. Haveselskabet) • Professionals such as: gardeners, nurseries, gardens centres, aquaria shops and retailers (selling aquatic plants that may also be used outdoors), and their associations (e.g. Dansk Gartneri) • Specialized websites and magazines • Municipalities (waste disposal) • Naturalist associations • Reporting systems (including Miljøstyrelsen, municipalities) • General public • For aquatic plants, possibly also anglers and people using leisure boats
<p>Already in place in Denmark</p> <ul style="list-style-type: none"> • Miljøstyrelsen's campaign on garden plants, with guides on how to choose plants, on individual invasive species (but mostly not those on the EU List) and on correct disposal of garden waste. • Guidelines for persons trading species are available on Miljøstyrelsen's site (incl. on invasive species, the ban of species on the EU List, and the need to inform clients ('Sådan undgår du at sælge invasive arter, March 2018'). • Some online systems/apps to report species exist, e.g. Miljøstyrelsen or 'Tip Kommunen' for Danish municipalities (although being multi-purpose and not promoted for the case of invasive alien species).
<p>International guidance. None found.</p>
<p>Countries for which information was found</p> <p>The information found related primarily to guidelines for users, incl. on removal and control.</p> <p>Sweden. Guidelines for gardeners and the public, including on the removal and disposal of invasive plants (Naturvårdsverket).</p> <p>UK. Various guides for gardeners, including on alternatives that may be used (Plantlife-RHS, 2010a & b). 'Be Plant Wise' campaign in relation to aquatic plants, targeting retailers and the public (nonnativespecies.org, 2018).</p> <p>Ireland and Northern Ireland. A Horticulture Code of Good Practice (Kelly, 2012) targeting professionals (plant producers, nurseries, wholesalers, garden centres and retailers of plants, as well as landscapers, landscape architects, local authorities and those with responsibilities for parks, properties and landcovers) deals with waste disposal, among other issues.</p> <p>France. From a general search, it seems that issues of invasive plants in gardens have been extensively dealt with in national newspapers, television, specialized magazines (home, garden).</p> <p>Switzerland, Ticino. Visual guide on invasive plants, including control (Ticino, 2016).</p> <p>Canada. Recommendations on choosing seeds and seed mixtures for garden use (bird seeds is covered under pathway Agriculture-Contaminant) (Invasiveplantscouncilbc, 2014). General recommendations on plants, incl. description of a system organizing stakeholders with partners, 'ambassadors' and the gardening community (Invasiveplantscouncilbc, 2016).</p>
<p>Possible measures</p> <ul style="list-style-type: none"> • Encouraging owners to identify and remove the plants of the EU List from their gardens (with appropriate guidance on removal and destruction). • Addressing the issue of Internet ordering (for trade and for exchanging plants). • Different brochures for gardens and for garden ponds in Sweden (Willen E. 2007, Naturvårdsverket och Havs Vatten myndigheten) encourage avoiding invasive species, proper disposal of plant material and of pond water (especially not to empty pond water close to waterbodies or watercourses). • Proposing alternatives to invasive alien species, both for terrestrial and aquatic (as done for aquatic plants in Sweden, Willen, 2007; aquatic and terrestrial plants in the UK, Plantlife- RHS, 2010a & b). • Reporting finding in nature https://www.naturvardsverket.se/Var-natur/Djur-och-vaxter/Invasiva-frammande-arter/Rapportera/ • Developing and promoting user-friendly reporting systems, and associated mechanisms to validate records. • Ensuring that waste disposal facilities have appropriate procedures to dispose of invasive plants waste. • Information to gardeners and on the invasive alien species, through professionals (retailers), associations, municipalities, medias, websites, newspapers, magazines. • Seed mixtures. The Invasive Species Council of British Columbia (Canada) raises the issue of seed mixtures for planting (invasiveplantscouncilbc, 2014). Although this relates to intentional import, it is not known how the composition of such seed mixtures would be documented in the EU and how retailers

would avoid unintentionally selling seeds of plants on the EU List.
<ul style="list-style-type: none"> Promoting/supporting local groups of volunteers working to combat populations of invasive alien plants.
Reassessment of priority. Unchanged, High (Group A).
References Heywood V., Brunel S. 2009. Code of conduct on horticulture and invasive alien plants. Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) Nature and environment, no. 162. Invasive Plant Council of British Columbia. 2014. Targeted Invasive Plant Solutions. Seed mixtures. https://prrd.bc.ca/wp-content/uploads/2014/12/Seed_Mixtures_WEB.pdf Invasive Plant Council of British Columbia. 2016. Be PlantWise Choose Non-Invasive Plants for your Garden. https://bcinvasives.ca/documents/PlantWise_TIPS_Final_03_17_2016.pdf Kelly J. 2012. Horticulture code of good practice to prevent the introduction and spread of invasive non-native species. V2.0. Prepared as part of Invasive Species Ireland. Naturvårdsverket och Havs Vatten myndigheten. Råd om hur du hindrar spridning av invasiva främmande arter i och från din trädgård. https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8803-3.pdf?pid=22226 Naturvårdsverket. Avoiding spread. https://www.naturvardsverket.se/Var-natur/Djur-och-vaxter/Invasiva-frammande-arter/ Nonnativespecies.org. 2018. Invasive aquatic plants can damage our ponds, waterways and the environment. http://www.nonnativespecies.org/beplantwise/ Plantlife-RHS. 2010a. Gardening without harmful invasive plants. A guide to plants you can use in place of invasive non-natives. Available at http://www.plantlife.org.uk Plantlife-RHS. 2010b. Keeping ponds and aquaria without harmful invasive plants A guide to plants you can use in place of invasive non-natives. Available at http://www.plantlife.org.uk Ticino. 2016. Guida alle neofite invasive Riconoscere le piante problematiche e affrontarle in modo corretto. Visual guide. https://m4.ti.ch/fileadmin/GENERALE/organismi/documenti/Guida_alle_neofite_invasive_Schede_informativa.pdf Willen E. 2007. Havs og Vatten Myndigheten. Har du något förbjudet som växer i din trädgårdsdam? Available at http://www.naturvardsverket.se/Var-natur/Djur-och-vaxter/Invasiva-frammande-arter/

4.3 Secondary introduction

SECONDARY INTRODUCTIONS	
Species of the EU List From other countries (and DK if species is established) <i>Alopothen aegyptiaca</i> (esp. BE, DE, NL, PL, SE, UK and spread within DK) <i>Asclepias syriaca</i> (DE, esp. through corridors) <i>Corvus splendens</i> (NL) <i>Elodea nuttallii</i> (DE and spread within DK) <i>Eriocheir sinensis</i> (DE and spread within DK) <i>Heracleum mantegazzianum</i> (DE and spread within DK) <i>Impatiens glandulifera</i> (DE and spread within DK) <i>Nyctereutes procyonoides</i> (DE and spread within DK) <i>Ondatra zibethicus</i> (DE and spread within DK) <i>Orconectes limosus</i> (DE) <i>Oxyura jamaicensis</i> (esp. FR, NL, BE) <i>Pacifastacus leniusculus</i> (DE but mostly spread within DK) <i>Percottus glenii</i> (esp. PL) <i>Procambarus clarkii</i> (DE) <i>Procambarus fallax</i> spp. <i>virginalis</i> (DE) <i>Procyon lotor</i> (DE) <i>Pseudorasbora parva</i> (DE and spread within DK) <i>Tamias sibiricus</i> (DE) <i>Threskiornis aethiopicus</i> (esp. FR, NL)	Within DK (spread only) <i>Cabomba caroliniana</i> <i>Heracleum persicum</i> <i>Heracleum sosnowskyi</i> <i>Lysichiton americanus</i> <i>Muntingia calabura</i> (not established)

<i>Vespa velutina</i> (DE)
<p>Coverage. This pathway covers natural spread from other countries and spread within Denmark.</p> <p><i>From other countries</i></p> <p>Whether natural spread into Denmark may happen depends on the species' current distribution, mode of dispersal (e.g. watercourses), and biology (e.g. rate of dispersal etc.). In this study, it was not possible to make a detailed assessment for each species. The assessment was mainly based on EU risk assessments and complementary information (e.g. EU workshop on invasive alien species). The distribution of species may have changed significantly in the meantime (expansion, extinction or eradication).</p> <p>Birds may reach Denmark from further away, and several countries are listed as possible sources (retaining only northern European countries – complete distributions are given in the spreadsheet).</p> <p><i>Percottus glenii</i> may reach Denmark from Poland through Østersøen.</p> <p>For most species, this pathway proved relevant when the species is present in Germany at locations where it could reach Denmark (Sønderjylland). The distribution within Germany was therefore searched for all species, even if secondary introductions were not covered by the EU risk assessment. Secondary introduction was also considered a pathway when mentioned as a possibility in the factsheets of the Danish Ministry of Environment and Food. It was not considered a pathway (under current conditions) if the species was present only far from the Danish borders (e.g. in South Germany for a plant). However, the distribution data found was not always up-to-date (e.g. maps of flora from 2013), and an in-depth analysis of this pathway is probably still needed.</p> <p>The uncertainty as regards natural spread from Germany is low for some species: natural spread is known to occur for <i>Nyctereutes procyonoides</i> and <i>Ondatra zibethicus</i> (which also spread within Denmark); and recent information is available for some species with regards their establishment in Schleswig-Holstein (www.schleswig-holstein.de) bordering to Denmark (although no detailed geographical data was available, and the species may still be far from the border).</p> <p>Only for few species were transport corridors (railway, roads) mentioned as important in EU risk assessments (<i>Asclepias syriaca</i>, <i>Muntiacus reevesii</i>); however, corridors are known as being generally important vectors for the spread of invasive species, and may apply to other species on the list.</p> <p><i>Within Denmark</i></p> <p>A number of species which are established in Denmark can spread naturally from other countries and within Denmark. For some other species established in Denmark, introduction from other countries was considered unlikely due to their current distribution and mode of spread, but natural spread may occur within Denmark. <i>Muntiacus reevesii</i> is not established in Denmark currently, but was added to this list because young individuals have been observed in Jylland.</p>
<p>Volume of the pathway. The volume on this pathway would depend on the current populations and distribution of the species in other countries (and in Denmark), and on whether management or eradication measures are applied. This study was mostly based on the EU risk assessments and therefore the situation of individual species (distribution, and whether management has been applied) may have already changed. For example <i>Oxyura jamaicensis</i> is currently subject to an eradication campaign within the EU (Hall, 2016). Spread within Denmark is known for some species, such as <i>Nyctereutes procyonoides</i> and <i>Ondatra zibethicus</i>. In some cases, whether spread has been natural or human-assisted is not certain, but it cannot be excluded that some natural spread may occur.</p>
<p>Temporal changes. For birds, the risk of secondary introduction may increase as more outbreaks occur in the current countries or in new countries. For other species, the risk may increase as they extend their distribution within Germany for terrestrial animals and all plants, or if the distribution expands within Denmark. Secondary introduction may in time become possible for species that are currently far from the Danish borders.</p> <p>The temporal changes on this pathway will also depend on management programmes applied, which would slow down or suppress natural spread (see <i>Oxyura jamaicensis</i> eradication programme below).</p>
<p>Stakeholders</p> <ul style="list-style-type: none"> • Authorities in charge of invasive alien species and EU Directive 1143/2014 in EU countries • Other Danish authorities (e.g. Naturstyrelsen, Fiskeristyrelsen) • Naturalist organizations (e.g. Dansk Ornitologisk Forbund, Danmarks Naturfredningsforening) • Professional organisations, clubs etc. (as mentioned under other pathways) • Hunters and their associations • Other relevant organizations (e.g. Hedeselskabet) • Municipalities, road authorities and Falck in relation to recording traffic-killed animals

<p>Already in place in Denmark.</p> <ul style="list-style-type: none"> • Various campaigns and national regulations are already in place against some species, including official control programmes (e.g. <i>Nyctereutes procyonoides</i>, <i>Heracleum mantegazzianum</i>). • Information campaigns have been launched. • No information was found on possible specific measures to address possible secondary introduction of the species concerned from Germany. • Reporting systems (e.g. Miljøstyrelsen).
<p>International guidance</p> <p>WGIAS (2017a & b) provide detailed guidance on surveillance and management of invasive alien species, including the use and limitations of different management methods.</p> <p>EPPO (2006) details possible management measures for invasive alien plants, and EPPO (2014) national regulatory control systems against invasive alien aquatic plants. Specific national regulatory control systems have been developed for <i>Heracleum mantegazzianum</i>, <i>H. sosnowskyi</i> and <i>H. persicum</i> (EPPO, 2009), as well as for other species that are not yet present in Denmark (e.g. <i>Baccharis halimifolia</i>, <i>Microstegium vimineum</i>). EPPO PRAs on plants deal with issues of containment and eradication for each species (references are in the spreadsheet).</p> <p>A common system allowing countries to share information on management and eradication (incl. their national plans or activities on individual species), would benefit all member states. It is not known if such a system is already in place or in preparation.</p>
<p>Countries for which information was found</p> <p>UK, Belgium, France, The Netherlands: The RINSE EU project produced best practices on management of invasive animals and aquatic plants, incl., for species of immediate relevance to Denmark: eradication of <i>Ondatra zibethicus</i>, management of <i>Muntiacus reevesii</i> and <i>Alopochen aegyptiaca</i>, and management of aquatic invasive plants. In addition, it developed best practices on encouraging community engagement, volunteering and citizen science in the control of non-native species, and on catchment-level strategies for the management of invasive non-native species (RINSE website).</p> <p>Germany. Schleswig-Holstein has a dedicated website on invasive species. Guidelines on the management of 16 species are given (species established in Germany, not all in Schleswig-Holstein). Possible measures are briefly described and in some cases their cost, as well as data on the situation within Germany.</p> <p>For example for <i>Procyon lotor</i>, recommendations relate to enclosure of potential nest trees to prevent access, enclosure of preferred habitats to reduce invasion and reproduction (very high costs), protection against access to bat and bird nests associated with human dwellings, public awareness against food, compost and pet food being left outdoors. Hunting (shooting or traps with automatic alarms) is considered meaningful only in areas with threatened species (e.g. of amphibians and turtles) or large wet meadows, and where there are barriers against reinvasions; it is often combined with management of other predators. 160 individuals were killed in 2017 (Schleswig-Holstein.de).</p> <p>EU. An eradication programme against <i>Oxyura jamaicensis</i> is continuing in EU countries where this bird is/was established (Hall, 2016).</p> <p>Sweden, Finland, Germany. The measures applied against <i>Nyctereutes procyonoides</i> were described in MST (2010).</p> <p>Spain. Eradication of <i>Procyon lotor</i> (Garcia et al., 2012).</p> <p>Switzerland. Services in charge of maintenance of roads, railways, watercourses and other infrastructures should plan and execute works in a way that prevent establishment and spread of invasive alien species. Similar recommendations are made to municipalities and landowners (Confédération Suisse, 2016).</p> <p>For species that are not yet likely to reach Denmark through natural spread, action plans may be available in various countries (e.g. outcome of the Rinse project; action plan against <i>Callosciurus erythraeus</i> in France, Chapuis et al., 2011; successful eradication of <i>Callosciurus erythraeus</i> in Flanders, Adriaens et al., 2015; EC-Square project on <i>Sciurus carolinensis</i> in Italy).</p> <p>Much material has been produced on other invasive species, and may be useful, for example from France, leaflet on reporting and control of <i>Ambrosia</i> targeting the public (signalement-ambrosie.fr, 2018).</p>
<p>Possible measures</p> <ul style="list-style-type: none"> • Extending existing information and control campaigns to other species, or developing specific containment or eradication plans. • Action plans implemented against some species may be adjusted for use against others. The plan against <i>Nyctereutes procyonoides</i> is currently being enlarged to <i>Procyon lotor</i> (and <i>Mustela vison</i> – not on the EU List). A range of measures were envisaged when developing the plan against <i>Nyctereutes procyonoides</i>, and their cost-effectiveness evaluated (MST, 2010). Among measures that have not been retained, some

may be relevant in the future or for other animals. Some measures were rated as expensive, such as the use of early warning systems with infrared surveillance cameras and baited sites, enclosure of sensitive areas, GPS, use of specially-trained dogs. Rewards in the form of gift cards or money had also been envisaged.

- Exchange of information with the authorities of relevant EU countries/regions (especially in relation to distribution of the species and management applied), and monitoring of the situation within Denmark.
- Early detection and control of species (incl. through citizen science with appropriate information, trapping, reporting etc.) focusing on locations that are especially at risk of natural spread for each species within Denmark, e.g. at the border with Germany, sensitive areas particularly threatened by a species, coastlines leading to other parts of Denmark. Awareness-raising and training to inform/mobilize the public and relevant stakeholders (depending on species) to improve early detection, generally but especially in areas where entry via natural spread may occur in the near future.
- Research is going on for many species, but it was not possible to assemble complete elements in the limited time of this study. For example, research is being carried out on radio-telemetry for early detection of *Vespa velutina* (Kennedy et al., 2018).

Reassessment of priority. Unchanged, High priority (Group A), but needs to be reassessed for some species based on up-to-date information from relevant EU countries and detailed distribution within Denmark.

References

- Adriaens T., Baert K., Breyne P., Casaer J., Devisscher S., Onkelinx T., Pieters S., Stuyck J. 2015. Successful eradication of a suburban Pallas's squirrel *Callosciurus erythraeus* (Pallas 1779) (Rodentia, Sciuridae) population in Flanders (northern Belgium). *Biological Invasions* 2015.
- Chapuis J.L. et al., 2011. Plan national de lutte relatif à l'écureuil à ventre rouge (*Callosciurus erythraeus*) dans les Alpes-Maritimes.
- Confédération Suisse. 2016. Stratégie de la Suisse relative aux espèces exotiques envahissantes Annexe au rapport du Conseil fédéral répondant au postulat du 21 juin 2013 13.3636, « Mettre un terme à l'expansion des espèces exotiques envahissantes », du conseiller national Karl Vogler. 18 Mai 2016.
- EPPO. 2006. Standard PM3/67 'Guidelines for the management of invasive alien plants or potentially invasive alien plants which are intended for import or have been intentionally imported'.
- EPPO. 2009. PM 9/9(1) *Heracleum mantegazzianum*, *H. sosnowskyi* and *H. persicum*. OEPP/EPPO, Bulletin OEPP/EPPO Bulletin 39, 465–470.
- EPPO. 2014. National regulatory control systems PM 9/19 (1) Invasive alien aquatic plants. Bulletin OEPP/EPPO Bulletin (2014) 44 (3), 457–471.
- Garcia et al. 2012. Recent invasion and status of the raccoon (*Procyon lotor*) in Spain. *Biol. Invasions* (2012) 14:1305–1310.
- Hall, C. 2016. *A review of the progress against the Action Plan for Eradication of the Ruddy Duck Oxyura jamaicensis in the Western Palearctic, 2011 –2015*. WWT report to the Bern Convention.
- Kennedy P.J., Ford S.M., Poidatz J., Thiéry D, Osborne J.L. 2018. Searching for nests of the invasive Asian hornet (*Vespa velutina*) using radio-telemetry. *Communications Biology*, Volume 1, Article number: 88.
- RINSE website. EU Project RINSE (Reducing the Impact of Non-Native Species in Europe). <http://www.rinse-europe.eu/>
- Schleswig-Holstein.de. 2018. Land website. <https://www.schleswig-holstein.de/DE/Fachinhalte/A/artenschutz/ManagementinvasiverArten.html;jsessionid=FA4A90563CA002227491E88A6ECD53C7>
- Signalement-ambroisie.fr. 2018. Comment participer à la lutte contre l'ambroisie ? http://www.signalement-ambroisie.fr/media/Flyer_AmbroisieV4.pdf
- WGIAS. 2017a. Working Group on Invasive Alien Species. Surveillance of Invasive Alien Species of Union concern.
- WGIAS. 2017b. Working Group on Invasive Alien Species. 2017. Management of Invasive Alien Species of Union Concern.

4.4 Aquaria (escape, contaminant)

AQUARIA-ESCAPE	
Species of the EU List Animals <i>Lithobates catesbeiana</i> <i>Orconectes limosus</i> <i>Orconectes virilis</i> <i>Percottus glenii</i> <i>Procambarus clarkii</i> <i>Procambarus fallax</i> spp. <i>Virginalis</i> <i>Pseudorasbora parva</i> <i>Trachemys scripta elegans</i> <i>Trachemys scripta scripta</i> <i>Trachemys scripta troosti</i>	
	Plants <i>Alternanthera philoxeroides</i> <i>Cabomba caroliniana</i> <i>Eichhornia crassipes</i> <i>Elodea nuttallii</i> <i>Hydrocotyle ranunculoides</i> <i>Lagarosiphon major</i> <i>Ludwigia grandiflora</i> <i>Myriophyllum aquaticum</i> <i>Myriophyllum heterophyllum</i>
Coverage. Escape into nature of plants or animals that have been intentionally introduced for use in aquaria. Escapes can happen during maintenance operations (e.g. cleaning or changing water) or to dispose of some individuals (e.g. too big, too many, not wanted anymore, change of aquarium landscape etc.). Aquaria open to the public more than 7 days per year would fall under the legislations for zoos, and the guidance detailed under Escapes-Zoo would apply.	
Volume of the pathway. The EU list contains ornamental plants and animals that have been widely used in aquaria. Among the subspecies of <i>Trachemys scripta</i> , <i>T.s. scripta</i> and <i>troosti</i> had been used as alternatives to <i>T. s. elegans</i> , and the latter is probably more widespread.	
Temporal changes. Sale and exchange of the plants on the EU List is banned. However, temporal changes will depend also on whether owners are aware that they should not exchange or hand out these plants and animals anymore. Individuals will progressively die. A number of species are not currently able to establish in Denmark (<i>Alternanthera philoxeroides</i> , <i>Eichhornia crassipes</i> , <i>Procambarus clarkii</i>) and some others have not shown able to reproduce in Denmark to date. However, this may change in the future.	
Stakeholders <ul style="list-style-type: none"> • Aquarium owners, and their clubs and associations (e.g. Dansk Akvarie Union) • Professionals: aquaria shops and retailers (selling aquatic plants and animals, as well as material and food) • Municipalities (waste disposal) • Specialized websites and magazines • Anglers associations, naturalist associations • Reporting systems (including through Miljøstyrelsen, municipalities) • See Escapes-Zoo for aquaria that fall under the legislation for zoos 	
Already in place in Denmark <ul style="list-style-type: none"> • Campaign on delivering species of the EU List to registered facilities. No specimen of the species on this pathway is mentioned in the corresponding news items on Miljøstyrelsen website, but these are possibly not exhaustive. • Key to crayfish in nature (Miljøstyrelsen). • Guidelines for persons trading species are available on Miljøstyrelsen's site (incl. on invasive species, the ban of species on the EU List, and the need to inform clients (Sådan undgår du at sælge invasive arter, March 2018). • Some online systems/apps to report species exist (e.g. Miljøstyrelsen). 	
International guidance. European Code of Conduct on Pets and Invasive Species (Davenport & Collins, 2016). See Escapes-Zoo for aquaria that fall under the legislation for zoos.	
Countries for which information was found. No specific measures or guidance was found. Aquaria plants are generally treated together with aquatic outdoor plants, and aquarium animals with pets.	
UK. Guide on alternative plant species that may be used in ponds and aquaria (Plantlife-RHS, 2010).	
Possible measures <ul style="list-style-type: none"> • The European Code of Conduct recommends promoting awareness of IAS and the problems they may cause, promoting the message that members of the public should never deliberately release pets, promoting awareness that releasing pets is often cruel to the animal, and encouraging the pet trade to 	

<p>provide detailed information on the animals on sale (e.g. potential size when fully grown, etc.), so that buyers make an informed choice (this does not apply to the species on the EU list, as sale is banned).</p> <ul style="list-style-type: none"> • For bigger aquaria that are not subject to the same legislation as zoos (e.g. because they are open less than 7 days per year), some measures recommended for zoos may be relevant (see Escapes-Zoo). • Proposing alternatives to invasive alien species (as Plantlife-RHS, 2010). • Developing user-friendly reporting systems, and associated mechanisms to validate records. • Ensuring that waste disposal facilities have appropriate procedures to dispose of invasive plants waste. • Targeted information to aquaria owners on the invasive alien species, and especially on adequate disposal of species and water, through associations, municipalities, medias, websites, newspapers, magazines.
Reassessment of priority. Unchanged, High (Group A).
References Plantlife-RHS. 2010. Keeping ponds and aquaria without harmful invasive plants A guide to plants you can use in place of invasive non-natives. Available at http://www.plantlife.org.uk

AQUARIA-CONTAMINANT
Species of the EU List. <i>Plant</i> , <i>Hydrocotyle ranunculoides</i>
Coverage. <i>H. ranunculoides</i> may contaminate consignments of other aquatic plants. The EU risk assessment notes that the plant may still be sold in the UK as <i>H. vulgaris</i> or <i>H. novae-Zelandia</i> and that labelling is unreliable. This relates to an intentional – though illegal – introduction pathway and is not covered here.
Volume of the pathway. Not searched.
Temporal changes. Not searched.
Stakeholders. Owners of aquaria and garden ponds, retailers selling aquatic plants.
Already in place in Denmark. Not searched.
International guidance. Not searched.
Countries for which information was found. Not searched.
Possible measures. In the EPPO PRA, this was considered as a spread pathway (EPPO, 2009), but no measures are indicated. No information was found. The measures against Aquaria-Escape and Horticultural-Escape may ensure that the plant, if it grows in an aquarium or a pond because it was contaminating others, is not released into nature. General awareness-raising is also relevant, to end-users and retailers.
Reassessment of priority based on measures. Unchanged, Very low priority (Group D). However, could be covered under Aquarium-Escape and Horticulture-Escape, with awareness-raising on the possible contamination of aquatic plants by others.
References EPPO. 2009. Pest risk analysis for <i>Hydrocotyle ranunculoides</i> . 09/15108rev. GNNSS. 2011. Floating Pennywort - <i>Hydrocotyle ranunculoides</i> . 16/03/2011.

4.5 Agriculture (escape, contaminant)

AGRICULTURE-CONTAMINANT	
Species of the EU List	
Plants	Animal
<i>Alternanthera philoxeroides</i>	<i>Vespa velutina</i>
<i>Microstegium vimineum</i>	
<i>Parthenium hysterophorus</i>	
<p>Coverage. For plants, this pathway related to contamination of bird seeds (<i>Alternanthera philoxeroides</i>, <i>Microstegium vimineum</i>), of plants with soil (<i>Microstegium vimineum</i>, <i>Vespa velutina</i>) and of grain and seeds (<i>Parthenium hysterophorus</i> – grain: cereals, maize, including for animal feed; seeds - pasture, cereal, soybean are mentioned in the EU risk assessment). Hay is mentioned for <i>Microstegium vimineum</i> in the EU risk assessment (EPPO, 2016), but is considered anecdotal and not detailed in the PRA; it is not considered further in this study.</p> <p>In addition <i>Vespa velutina</i> (as hibernating queens or nests) may contaminate soil associated with plants for planting, as well as consignments of fruit or cut flowers (as workers or queens – but only queens present a risk of establishment).</p> <p>Association with plants for planting with soil could be dealt with as under Horticulture-Contaminant (see under this pathway). However, different stakeholders may need to be targeted, especially importers of plants</p>	

with soil for agricultural purposes. Other associations are covered below.
Volume of the pathway. Unknown. Bird seeds are a known pathway for unintentional introduction of non-native plants (EPPO, 2010). The EFSA opinion on the presence of seeds of <i>Ambrosia</i> spp. in animal feed noted that grains fed to livestock generally undergoes some form of processing, which would limit survival, while bird seeds do not. One recommendation was that mechanical procedures can reduce the rate of contamination of sunflower seed, and that cleaning techniques for all seeds used in bird feed need to be developed (EFSA, 2010). No information was found on whether such cleaning techniques are now available and used.
Temporal changes. Two species are unlikely to establish in Denmark at present (<i>Alternanthera philoxeroides</i> and <i>Parthenium hysterophorus</i>).
Stakeholders <ul style="list-style-type: none"> • Other authorities (Landbrugstyrelsen – phytosanitary regulations, seed regulation; Fødevarestyrelsen – animal feed, Customs) • Bird seeds importers, relevant grain and seed importers • Stakeholders for import of seeds and grain, including producers and farmers. • For fruit and cut flowers, importers and retailers • General public, naturalists associations etc.
Already in place in Denmark <ul style="list-style-type: none"> • Although invasive plants are not covered by the EU plant health legislation (incl. new EU Regulation 2016/2031 due to substitute EU Directive EU 2000/29 and associated regulations), various existing phytosanitary requirements may to some extent limit the association of the species concerned as contaminant for consignments from outside the EU; however, some requirements may not apply to all third countries, and even less so for imports to Denmark from other EU countries. • Some commodities (especially seeds) are subject to specific requirements in relation to other regulations (e.g. seed quality). Some requirements under the EU Marketing Directives would apply. For example the EU Directive on cereal seeds (1966/402/EEC) provides for a maximum content of seeds of other plant species. • EU Directive 2002/32/EC on undesirable substances in animal feed includes a maximum content (at detection level) for seeds of <i>Ambrosia</i> (the only contaminating plant covered) in animal feed. • The awareness campaigns already in place may improve early detection.
International guidance ISPM 38 (2017) on international movement of seeds addresses plants as pests. A similar ISPM for grain is under development. EPPO PRAs for invasive plants identify measures that may be required to address specific pathways of introduction, including unintentional ones such as contamination. They provide that a phytosanitary certificate (PC) delivered by the exporting country attests that the requirements have been fulfilled. However, invasive plants are specifically excluded from the new EU phytosanitary regulation (2016/2031 of 26 Oct. 2016), do not fall under phytosanitary legislation in EU countries, and are therefore not covered by phytosanitary certificates. Implementing the measures recommended in EPPO PRAs would require that the EU regulation is amended or a parallel regulation using similar requirements and ‘certificates’ is developed for invasive alien species as contaminants (and covering imports from third countries and from within the EU). A pathway analysis for production and processing of small seeds for birds is summarized in EPPO (2007).
Countries for which information was found. No additional information was found directly on the species concerned, but general information or material on other species. France. Information leaflet, recommending sieving birdseeds with a 3 mm sieve to eliminate <i>Ambrosia</i> seeds (Anonymous, 2018). The Netherlands. Guidelines for producers on exporting oilseed for pet food to Europe (CBI, no date) cover bird seeds and provides information on quality and other aspects (but do not mention invasive plants). UK. For <i>Vespa velutina</i> , there have been several interceptions of the related species <i>Vespa orientalis</i> on fruit and plant produce imported in the UK, interceptions were mostly where produce is found, i.e. importers offices, market stalls etc. (EU risk assessment). For bird seeds, the Birdcare Standards Association provides standards and labels for bird seeds. Although they do not address specifically invasive plants may contribute to a better quality of bird seeds. Canada. recommendations on choosing bird seeds (Invasiveplantscouncilbc, 2018).
Possible measures

For plants, the requirements detailed in EPPO PRAs include:

- *Alternanthera philoxeroides*. For bird seeds, certification scheme for pest free production in the country of origin (EPPO, 2014).
- *Microstegium vimineum*. For bird seeds, confirmation that the consignment is free from *Microstegium vimineum* seed, provided by the country of origin (specifying surveillance and monitoring methods) (EPPO, 2016).
- *Parthenium hysterophorus*. For grain and seeds, pest-free area, or pest-free place of production/production site (with specific requirements detailed in the PRA), or certification scheme. For grain aimed to be crushed or transformed, option of import under special licence/permit and specified restrictions.

For *Vespa velutina*, it may be possible to design similar requirements as for quarantine pests, such as pest-free area, or production under specific conditions etc. However, such requirements may not be feasible given the large range of commodities involved. Defining requirements and their applicability would require a detailed study on risk management options for Denmark.

In all cases, non-regulatory options should facilitate early detection (as for other pathways), such as:

- bird seeds: general public (also through garden centers), bird seed retailers, producers of bird seeds at the EU level or to potential exporters (similar to CBI (no date) but with recommendations on invasive plants). It could be investigated if Standards for bird seeds (as Birdcare Standards Association), but also addressing invasive plants, would be useful.
- seeds: end-users and stakeholders.
- fruit and cut flowers: In the UK, the closely-related species *V. orientalis* has been intercepted at places of import (see above), and awareness-raising targeting fruit and flowers importers may improve early detection. Awareness campaigns for beekeepers and their associations, bee inspectors and other relevant stakeholders, including the general public would be relevant.

Reassessment of priority

For bird seeds: Very low priority (Group D), only two species are associated, which are not major. If taking into account species that cannot establish, the priority would be even lower (*Alternanthera philoxeroides* is currently unlikely to establish). However, bird seeds is a known pathway for introduction of invasive plants. For grain and seeds, and for fruit and cut flowers, Very low priority (Group D) (one species for each). Grain and seeds may not be a priority at present as *P. hysterophorus* is currently not able to establish. Agriculture-Contaminant was in Group B (Medium priority) because vectors were considered together, but they need to be addressed differently.

References

- Anonymous. 2018. Vous aimez les oiseaux, mais ATTENTION: les oiseaux sèment. https://www.riom-communaute.fr/fileadmin/user_upload/Vivre_RiomCo/Cadre_de_Vie_RIomCo/Environnement/Attention_les_oiseaux_sement.pdf
- Birdcare Standards Association. <http://www.birdcare.org.uk/>
- CBI. no date. Exporting oilseed for pet food to Europe. <https://www.cbi.eu/node/2287/pdf/>
- EPPO. 2007. Pathway analysis: production and processing of small seeds for birds. Article EPPO Reporting Service. EPPO Reporting Service no. 06 - 2007 Num. article: 2007/122.
- EPPO. 2010. Risks of introduction of alien plant species via seeds imported for fodder and birdseed EPPO Reporting Service no. 03 - 2010 Num. article: 2010/069.
- EPPO. 2016a. EPPO pest risk analysis for *Microstegium vimineum*. 16-21488. EPPO, Paris, France. Available from <https://www.eppo.int>
- EPPO. 2016b. Pest Risk Analysis for *Alternanthera philoxeroides*. 16-21485. Available from <https://www.eppo.int>
- Invasive Plant Council of British Columbia. 2014. Targeted Invasive Plant Solutions. Seed mixtures. https://prrd.bc.ca/wp-content/uploads/2014/12/Seed_Mixtures_WEB.pdf
- ISPM 38. 2017. International Standard for Phytosanitary Measures. *International movement of seeds*. Rome, IPPC, FAO. <https://www.ippc.int>

AGRICULTURE-ESCAPE
Species of the EU List. Plants, <i>Asclepias syriaca</i> , <i>Pueraria lobata</i>
Coverage. This pathway related to escape from agricultural use as fibres, oil, rubber, pharmaceuticals, biofuel and others for <i>Asclepias syriaca</i> , and as fodder, erosion control and nitrogen fixing for <i>Pueraria lobata</i> .
Volume of the pathway. These pathways were mentioned in the EU risk assessments, and were retained. However, they are unlikely to apply to Denmark at present, i.e. it is unlikely that these plants are grown in Denmark for agricultural purposes at present. <i>Pueraria lobata</i> is currently unlikely to establish in Denmark, and the current climatic conditions in Denmark are not optimal to grow <i>Asclepias syriaca</i> .
Temporal changes. Climate change may render establishment and cropping of these plants possible in the future. Among the uses mentioned, especially pharmaceutical use and use, biofuel and environmental uses may trigger research and a wish for future use, and the plants may escape. <i>P. lobata</i> has been identified as an 'underexploited industrial crop'.
Stakeholders <ul style="list-style-type: none"> • pharmaceutical research or industry • stakeholders for biofuel and environmental uses
Already in place in Denmark. not searched
International guidance. not searched
Countries for which information on measures was found. Not searched
Possible measures. Similar as to Horticulture-Escapes, with awareness-raising measures towards relevant stakeholders (especially to inform them of the current ban on import of these species). It is not clear whether in their search for new interesting compounds/properties from plants, these stakeholders would be aware of the issues posed by invasive alien species.
Reassessment of priority based on measures. Unchanged, Very low priority (Group D).
References. -

4.6 Aquaculture (escape, contaminant)

AQUACULTURE-ESCAPE
Species of the EU List. Animals, <i>Pacifastacus leniusculus</i> , <i>Procambarus clarkii</i> .
Coverage. This pathway relates to the escape of two crayfish from aquaculture facilities.
Volume of the pathway. Unknown.
Temporal changes. Unknown.
Stakeholders <ul style="list-style-type: none"> • Aquaculture companies and their associations (Dansk Akvakultur) • Authority (Fødevarestyrelsen).
Already in place in Denmark. Law: Bekendtgørelse om udsætning af krebs i i ferske vande.
International guidance <p>The ICES Working Group on the Environmental Interactions of Aquaculture (WGEIA) considered mechanisms to minimize the risks of invasive species in aquaculture using a risk assessment-based pest management framework. If invasive alien species are present, then Hazard Analysis and Critical Control Points (HACCP) principles are used to identify critical control points and potential control measures (McKindsey et al., 2011). It was not possible to find more details.</p> <p>Note that the ICES Working Group on Environmental Interactions of Mariculture reviewed available treatments to avoid invasives in mariculture (WGEIM, 2006).</p>
Countries for which information on measures was found
Ireland. A marine aquaculture code of practice is under development (Invasive Species Ireland). Some elements may be relevant for freshwater species.
Possible measures <p>As mentioned above. The recommendations of the ICES WGEIA were not found.</p> <p>The EU risk assessment mentions biocide treatment to eradicate the species at the small number of major suppliers of fish for stocking; handling practice so wild-netted fish for stocking are held in floating cages to allow signal crayfish to climb out before fish are moved (EU, 2011). In addition, it identifies a need for further assessment of barriers to movement, and eradication.</p>
Reassessment of priority. Unchanged, Low priority (Group C) but further identification of measures is

needed.

References

- EU risk assessment. 2011. *Pacifastacus leniusculus* - Signal crayfish. GB Non-Native Organism Risk Assessment Scheme. Final 29/03/11.
- ICES. International Council for the Exploration of the Sea. www.ices.dk/
- Invasive Species Ireland. Draft Marine Aquaculture Code of Practice. Available at https://invasivespeciesireland.com/wp-content/uploads/2010/07/Aquaculture_CoP.pdf
- McKindsey C., Landry T., O’Beirn F. 2011. Preventing the Risk of Invasive Species in Aquaculture. p 171 in Solutions and Tools to Improve Aquatic Animal Health. Proceedings of the OIE Global Conference on Aquatic Animal Health. Aquatic Animal Health Programmes: their benefits for global food security 28–30 June 2011. Panama City (Panama).
- WGEIM. 2006. ICES CM 2006/MCC:03 Report of the Working Group on Environmental Interactions of Mariculture (WGEIM). 24–28 April 2006. Narragansett, Rhode Island, USA.

AQUACULTURE-CONTAMINANT	
Species of the EU List. Animals: <i>Lithobates catesbeiana</i> , <i>Pacifastacus leniusculus</i> , <i>Percottus glenii</i> , <i>Pseudorasbora parva</i>	
Coverage. This pathway relates to the contamination of fish consignment produced in aquaculture facilities. They include 1 frog, 1 crayfish and 2 fishes.	
Volume of the pathway. Unknown.	
Temporal changes. Unknown, but may increase importance if the established species spread within Denmark (<i>Pacifastacus leniusculus</i> , <i>Pseudorasbora parva</i>).	
Stakeholders. As for Aquaculture-Escape.	
Already in place in Denmark. Law: Bekendtgørelse om udsætning af krebs i ferske vande.	
International guidance. The EU regulations seem to relate mostly to disease prevention.	
Countries for which information on measures was found. See <i>Possible measures</i> below. It was not clear if these were recommendations or are used in practice.	
Reassessment of priority. Unchanged, Medium priority (Group B) but further identification of measures is needed.	
Possible measures Management options for <i>Percottus glenii</i> include checking fish transports for the presence of stowaway specimens, and control actions in case of fish stocking activities (Germany Schleswig-Holstein, 2018; Belgium Verreycken, 2015). Similar measures may be applicable to other species.	
References Adriaens T, Devisscher S, Louette G. 2013. Risk analysis report of non-native organisms in Belgium - American bullfrog <i>Lithobates catesbeianus</i> (Shaw). INBO. Schleswig-Holstein. 2018. Blaubandbärbling Management- und Maßnahmenblatt. https://www.schleswig-holstein.de/DE/Fachinhalte/A/artenschutz/Downloads/MMB_Blaubandbaerbling.pdf;jsessionid=831C698A92E70C34BC379E82BEE7334E?__blob=publicationFile&v=2 Verreycken H. 2015 Risk analysis of the Amur sleeper <i>Percottus glenii</i> . May 2015. INBO.	

4.7 Transport (travellers, vehicles and means of conveyance, leisure boats, livestock)

TRANSPORT – TRAVELLERS (INCL. SHOES, CLOTHES, LUGGAGE)	
Species of the EU List	
Plants	Animals
<i>Heracleum persicum</i>	<i>Orconectes limosus</i>
<i>Heracleum sosnowskyi</i>	<i>Vespa velutina</i>
<i>Microstegium vimineum</i>	
<i>Parthenium hysterophorus</i>	
Coverage. This pathway focuses on persons and their baggage. Vehicles are covered separately. Shoes and clothes were identified as vectors for several plants (<i>Heracleum persicum</i> , <i>Heracleum sosnowskyi</i> , <i>Microstegium vimineum</i> , <i>Parthenium hysterophorus</i>). <i>Vespa velutina</i> has been found associated with camping equipment brought back from France to the UK. It may become associated with material used for camping, hiking, or more permanently in summerhouses etc. <i>Orconectes limosus</i> was listed to cover the possibilities that travellers would bring back the species as bait. It is an intentional pathway, but travellers may not be aware of the current prohibition of the species on the EU List. Although only <i>Orconectes limosus</i> was listed here, it potentially applies to other species on the EU List, especially plants. This pathway has common stakeholders with Horticulture-Escapes, Angling, Transport-Vehicles.	
Volume of the pathway. Possibly high, relating to all persons that travel to areas where the species occur. For example, <i>V. velutina</i> occurs in Southern Europe, which is a popular holiday destination for Danes, including owners of holiday houses, and often accessed by car.	
Temporal changes. <i>Parthenium hysterophorus</i> is currently not likely to establish.	
Stakeholders <ul style="list-style-type: none"> General public, including all persons likely to travel. In the European Code of Conduct travellers are a wide audience, including tourists, crews, the military, scientists etc. It may apply to drivers of commercial vehicles, such as trucks. 	

<ul style="list-style-type: none"> • Operators involved in the travel/tourism sector and industry. • Operators of structures where information may be made available, such as travel agents, and entry facilities such as airports, ports, bus stations, motorway stops etc. • Customs and quarantine services. • Regional authorities in EU countries with a known large population of Danish tourists, and relevant operators in such areas (for accommodation, hunting, fishing, bird-watching, hiking, water sports, etc.).
<p>Already in place in Denmark</p> <p>Recommendation to clean shoes and boots, including before travelling, as well as luggage.</p> <p>Recommendation to not bring back plants and animals, including in the form of seeds adhering to shoes and clothes, or of fruit/vegetables with seeds (Miljøstyrelsen website).</p>
<p>International guidance</p> <p>European Code of Conduct on International Travel and Invasive Alien Species (Scalera, 2017).</p> <p>Campaigns targeting travellers for pests (EPPO), for endangered species (in relation to CITES) or for food safety, may provide useful material that may be adjusted to invasive alien species. e.g.</p> <ul style="list-style-type: none"> • EPPO Communication kits. Don't Risk It! (posters, leaflets and brochures). https://www.eppo.int/RESOURCES/eppo_publications/don_t_risk_it • Campaign of the IATA targeting airlines. https://www.iata.org/policy/environment/Pages/wildlife-trafficking.aspx.
<p>Countries for which information was found</p> <p>Portugal: recommendation to travellers that car tyres, shoes and equipment should be cleaned http://invasoras.pt/conselhos-e-dicas/</p> <p>Italy. Campaigns in airports.</p> <ul style="list-style-type: none"> - The LIFE Gestire 2020 project includes the development of a program on IAS in an airport (Orio al Serio, Bergamo) with the establishment of an integrated office operating controls of alien species at entry and information activities to departing passengers, customs inspectors and other agents. A wider information campaign will be launched for travellers, airline companies, travel agencies, and the wider public. A questionnaire to departing passengers will allow understanding the current level of awareness. Information materials, a vademecum for the passenger and a video will be produced http://www.naturachevale.it/en/invasive-species/preventing-the-spread-of-new-invasive-species-through-air-vector/ - The LIFE ASAP campaign at Rome airport includes an information campaign with videos and a “Decalogue for responsible travellers” http://www.lifeasap.eu/index.php/it/component/content/article/13-eventi/155-informati-pensa-viaggia <p>Spain, Islas Baleares, airport and ports posters regarding bringing plant material (against the bacterium <i>Xylella fastidiosa</i>) (Govern Illes Balears, 2018).</p> <p>Sweden. Recommendation to bring alien species from travels https://www.naturvardsverket.se/Var-natur/Djur-och-vaxter/Invasiva-frammande-arter/</p> <p>UK. Don't risk it campaigns, asking travellers to not bring back plants to UK. https://www.hardysplants.co.uk/news/don-t-risk-it</p> <p>Other countries</p> <p>Australia. Keep your gear clean in the wild. https://invasives.org.au/project/keep-gear-clean-wild/</p> <p>North America. PlayCleanGo.org, including posters and videos. http://www.playcleango.org/resources/media-library</p> <p><i>In some countries,</i> stringent measures are implemented at points of entry (airports etc.), such as in Australia and New Zealand: luggage scanned for biological material, plant dogs, cleaning shoes and equipment at arrival etc. (Lougheed, 2007). In New Zealand, items that could present a risk (such as shoes, sport and outdoor equipment) must be declared on the passenger arrival card (MPI, 2018).</p>
<p>Possible measures</p> <p>There is a range of possible measures between awareness-raising and more drastic systems as applied in some countries. Many possible measures are identified in the European code of conduct, and a few are listed below:</p> <ul style="list-style-type: none"> • Avoid unintentional introduction and spread of IAS to and from the sites visited by travellers. The code also contains measures to prevent the move of species outside of areas visited by travellers. • Awareness-raising and outreach activities focusing on IAS and their impacts, and informing the general public on the risks linked to bringing back alien invasive species (see campaigns above). • Provide information and details on recommended actions to all travellers and tourists, preferably prior

to the start of any journeys.

- Consider the development of questionnaires to assess the validity and effectiveness of the measures implemented to prevent the introduction of invasive alien species.
- Information and communication campaigns for specific target audiences (e.g. information boards or flyers in airports, harbours, railways station, as well as border stations, travel offices etc.). Information campaigns at departure are made in some EU countries in relation to CITES, animal diseases, food safety, plant pests, and now also for invasive species (see Italy above).
- Audio-video material to be circulated through the appropriate media.
- Events and presentations on environmental education for employees, guests and community members (e.g. in accommodation places). (This could target Danish operators abroad).
- Recommendations for tourists and travellers such as: carefully wash boots and clean all equipment including clothes, bags, tripods, tents and walking sticks before bringing them to the travel destination and back home. Particular attention to boot treads, velcro fastenings and pockets which could contain soil or seeds.
- Early detection and action at main entry points for commercial/tourist arrivals (airports, ports, harbours, open moorings, train stations) and areas frequently visited by tourists; highly disturbed areas (land clearance, construction, storm damage) and areas where disturbance is regularly occurring (roads, railways etc.) is recommended (Scalera, 2017).

Reassessment of priority: Unchanged, Medium (Group B).

References

- Govern Illes Balears. 2018. Servicio de Sanidad Forestal. Prohibit Prohibido Forbidden Verboten. http://www.caib.es/sites/sanitatforestal/es/xylella_fastidiosa-80001/archivopub.do?ctrl=MCRST149ZI229011&id=229011.
- Lougheed T. 2007. Rooting Out Invasive Species Lessons from Down Under Environmental Health Perspectives. Vol. 115, nr. 7, July 2007.
- MPI. 2018. Items to declare. Biosecurity New Zealand. <https://www.mpi.govt.nz/travel-and-recreation/arriving-in-new-zealand/items-to-declare/>.
- Scalera R. 2017. European Code of Conduct on International Travel and Invasive Alien Species. T-PVS/Inf (2017) 1 [Inf01e_2017.docx] Convention on the Conservation of European Wildlife and Natural Habitats Standing Committee 37th meeting Strasbourg, 5-8 December 2017.

TRANSPORT- VEHICLES AND MEANS OF CONVEYANCE (ship, plane, truck, car, freight container, used machinery)

Species of the EU List

Plants

Baccharis halimifolia
Heracleum persicum
Heracleum sosnowskyi
Lysichiton americanus
Microstegium vimineum
Parthenium hysterophorus
Pennisetum setaceum

Animals

Corvus splendens
Herpestres javanicus
Vespa velutina

Coverage. All vehicles and means of conveyances were covered under this pathway.

Terrestrial vehicles were identified for several plants (*Baccharis halimifolia*, *Heracleum persicum*, *Heracleum sosnowskyi* *Microstegium vimineum*, *Pennisetum setaceum*) that can be associated with soil on vehicles, or as fragments. Some vehicles are specified in some EU risk assessment while others mentioned vehicles in general. Cars are specifically mentioned for *Heracleum persicum* and *Microstegium vimineum*, and trucks for *M. vimineum*.

Transport on machinery, such as agricultural machinery, may relate both to vehicles moving on their own across borders (this may be the case locally at the border with Germany) and to used machinery as a commodity; it applied to the same plants as above plus *Lysichiton americanus* and *Parthenium hysterophorus*.

Ships were identified as a vector for two animal hitchhikers: *Corvus splendens* and *Herpestres javanicus*.

For *Vespa velutina*, transport related to inseminated queens (as active adult hitchhikers) or dormant hibernating queens carried in freight containers and transport vehicles (the risk assessment mentioned plane and ship).

Train is not mention for the species of the EU List (but freight containers in particular may be transported by train).
<p>Volume of the pathway. Unknown, but there is a large traffic of vehicles and means of conveyances to Denmark.</p> <p><i>Corvus splendens</i> occurs in the Netherlands close to Rotterdam, from which there is large ship traffic, but the EU risk assessment assesses that the frequency of movement by ship-assisted transfer to the UK will be very rare.</p>
Temporal changes. <i>Parthenium hysterophorus</i> and <i>Herpestres javanicus</i> are currently unlikely to establish.
<p>Stakeholders</p> <ul style="list-style-type: none"> • Ship companies and authority (Søfartstyrelsen) • Transport companies by road, railway and air, and corresponding associations and authorities • Private persons travelling by car • Use of agricultural machinery across borders and trade of used machinery
Already in place in Denmark. Not searched.
<p>International guidance</p> <p>European Code of Conduct on International Travel and Invasive Alien Species (Scalera, 2017).</p> <p>The Handbook for Inspection of Ships and Issuance of Ship Sanitation Certificates (WHO, 2005) provides that storage areas should be inaccessible to animals, insects and birds. (this does not cover other areas of ships).</p> <p>It is noted that ballast seems to have been the main focus for addressing stowaway invasive species on ships.</p>
<p>Countries for which information on measures was found</p> <p>Portugal. recommendation to travellers that car tyres, shoes and equipment should be cleaned http://invasoras.pt/conselhos-e-dicas/</p> <p>USA. Measures are implemented against noxious weeds: washing the undercarriage of vehicles after driving through an area infested with a seed-producing noxious weed (Sheley et al., 2011).</p>
<p>Possible measures</p> <p>Measures for used machinery are detailed in ISPM 41, covering machinery used for purposes such as agriculture, forestry, construction, industrial purposes, mining and waste management, and measures also target plants. Guidance on used military vehicles is also provided. Implementation of ISPM 41 would necessitate collaboration with the phytosanitary authority.</p> <p>Cleaning of machinery is identified as a possible measure in some PRAs such as for <i>H. persicum</i> or <i>Microstegium vimineum</i>.</p> <p>Measures for the vehicles of travellers are given in the European Code of Conduct on International Travel and Invasive Alien Species (Scalera, 2017).</p> <p>Awareness-raising may be carried out on targeted audiences. It is not clear how much more stringent requirements could be implemented.</p>
Reassessment of priority. Unchanged, Medium (Group B).
<p>References</p> <p>ISPM 41. 2017. International Standard for Phytosanitary Measures. International movement of used vehicles, machinery and equipment. International Plant Protection Convention, Rome, FAO.</p> <p>Scalera R. 2017. European Code of Conduct on International Travel and Invasive Alien Species. T-PVS/Inf (2017) 1 [Inf01e_2017.docx] Convention on the Conservation of European Wildlife and Natural Habitats Standing Committee 37th meeting Strasbourg, 5-8 December 2017.</p> <p>Sheley R, Manoukian M, Marks G. 2011 Preventing Noxious Weed Invasions. Montana State University.</p> <p>WHO. 2005. Handbook for Inspection of Ships and Issuance of Ship Sanitation Certificates. World Health Organization. International Health Regulations.</p>

TRANSPORT – LEISURE BOATS
Species of the EU List. Plant, <i>Elodea nuttallii</i> .
<p>Coverage. This pathway was identified for <i>Elodea nuttallii</i>. It was not clear if such activities happen in the waterbody where <i>Cabomba caroliniana</i> is present in Denmark (in Hedeland, close to Roskilde), and the pathway was not retained for this species. However, it may also apply to other aquatic plants present in waterbodies where leisure boating is practiced. Leisure boating and the types of boats involved are detailed in the European Code of Conduct (below). Given the aquatic species currently on the EU List, the pathway relates mostly to freshwater, and boats such as rowing boats, kayaks, canoes, possibly stand-up paddling boards, windsurf, dinghies etc. The pathway covers those boats types and their equipment, and additional</p>

<p>material that may be in contact with water such as clothes, shoes, kayak skirts, containers, windsurf sails etc. Sailing boats are less relevant as there is no major freshwater sailing areas in Denmark, the largest being the lake system around Silkeborg. Thus, the very large seasonal ‘exchange’ of sailing boats among Denmark and, e.g., Sweden, Germany, and the Netherlands is in salty or brackish sea water and therefore of little relevance for the freshwater species.</p> <p>However, although this pathway was not identified for any saltwater species, in the UK <i>Eriocheir sinensis</i> is covered in the Check Clean Dry campaign for boats. Measures targeting divers and diving may be relevant for saltwater species.</p> <p>There are also movements of leisure boats between Denmark and other EU countries. The pathway is relevant for persons bringing leisure boats from EU countries into Denmark (for example neighbouring Sweden or Germany) or vice versa, or bringing back their boats to Denmark after using them in areas where aquatic species of the EU list are present.</p>
<p>Volume of the pathway. Not known. However, leisure boating is popular in Denmark, including kayaking, and there are also some movements of leisure boats within the EU. As regards the possible movement of freshwater species, kayaks and canoes seem to be the most relevant boat types.</p>
<p>Temporal changes. The pathway may become more important as the species spread in waterbodies, in Denmark or other EU countries.</p>
<p>Stakeholders</p> <ul style="list-style-type: none"> • People practicing boating, kayaking, canoeing, and other watersports during their leisure. • Their associations (e.g. Dansk Kano & Kajak Forbund; Havkajakroerne) and clubs. • Harbours. • Specialized magazines (e.g. Havkajak).
<p>Already in place in Denmark. Not searched.</p>
<p>International guidance. European Code of Conduct on Recreational Boating and Invasive Alien Species (Barton, 2006).</p>
<p>Countries for which information on measures was found</p> <p>UK. Campaign for boaters and kayakers (NNSS, 2018).</p> <p>Sweden. Recommendations to boaters, divers (Havochvatten, 2018).</p>
<p>Possible measures</p> <p>The European code of conduct recommends:</p> <ul style="list-style-type: none"> • Awareness, education, training, research and monitoring. • Check Clean and Dry programmes (see also NNSS 2018). • Adequate signage or guidance should be in place in boating hotspots, especially where aquatic invasive alien species are present. • Where practical, limiting access points on site, preferably to a single spot. • <i>On the water</i>, Avoid moving through water plants and weed if possible. • If the boat is on the water but not in use and stationary for a period of time, if possible, raise propellers out of the water to minimise the risk of invasive alien species entering the engine. • Appropriate care if moving structures or equipment which have been submerged in water for a time (such as pontoons, buoys). <p>Similar recommendations could also be made as for Angling regarding boats, equipment and clothes.</p>
<p>Reassessment of priority. Very low priority (Group D), because only one species of the EU List. However, it may also be relevant for some other species. Transport was originally in Group B-Medium priority because all vectors were considered together.</p>
<p>References</p> <p>Barton E. 2016. European Code of Conduct on Recreational Boating and Invasive Alien Species. T-PVS/Inf (2016) 13. Convention on the Conservation of European Wildlife and Natural Habitats. Standing Committee. 36th meeting. Strasbourg, 15-18 November 2016. Final version.</p> <p>Havochvatten. 2018. https://www.havochvatten.se/hav/fiske--fritid/arter/frammande-arter/hur-kan-jag-hindra-spridning-av-frammande-arter.html.</p> <p>NNSS. 2018. Biosecurity for boats and kayaks owners. http://www.nonnativespecies.org/checkcleandry/biosecurity-for-boat-and-kayak-users.cfm</p>

TRANSPORT – LIVESTOCK
Species of the EU List. Plants: <i>Heracleum persicum</i> and <i>Heracleum sosnowskyi</i> .
Coverage. For these species, this pathway relates to livestock having grazed in infested areas, and carrying seeds of the plants attached to their fur. It may be relevant both for introduction and spread.
Volume of the pathway. Not known. These plants have many other possible entry and spread pathways.
Temporal changes. The pathway may become more important as the species spread.
Stakeholders. Farmers, importers.
Already in place in Denmark. The current regulations on trade and imports of live animals (see https://ec.europa.eu/food/animals/live_animals_en) (also from within the EU) seem to focus on animal health and diseases.
International guidance. -
Countries for which information on measures was found
USA, Nevada. Measures to prevent the spread of noxious and invasive weeds include recommendations on cattle (incl. avoiding grazing or moving cattle through populations of noxious weeds while they are setting seed or when fruit is ripened; purging animals with weed-free feed for five days before moving them from infested to non-infested areas) (Siegel & Donaldson, 2003).
Possible measures
This pathway relates to two species that are already established in Denmark. Measures may be relevant to prevent the spread of the plants, similar to those recommended above. As grazing is also an effective method to control these species (Nielsen et al., 2005), it should not happen when the plants are setting seeds (and livestock prefers young plants according to Nielsen et al.). It is not known if there is import of livestock into Denmark and whether measures could be taken. This may need further consideration.
Reassessment of priority. Consider change to Low priority (Group C), both species associated have a major impact. Transport was in Group B- Medium priority because all vectors were considered together.
References
Nielsen C., Ravn H.P., Nentwig W., Wade M. (eds.). 2005. The Giant Hogweed Best Practice Manual. Guidelines for the management and control of an invasive weed in Europe. Forest & Landscape Denmark, Hoersholm, 44 pp.
Siegel S., Donaldson S. 2003. Measures to Prevent the Spread of Noxious and Invasive Weeds During Construction Activities University of Nevada Cooperative Extension. https://www.unce.unr.edu/publications/files/nr/2003/FS0359.pdf

4.8 Other-Contaminant (soil, ornamental fish, man-made goods)

OTHER CONTAMINANT: SOIL
Species of the EU List
<i>Baccharis halimifolia</i> <i>Heracleum persicum</i> <i>Microstegium vimineum</i>
<i>Heracleum mantegazzianum</i> <i>Heracleum sosnowskyi</i> <i>Persicaria perfoliata</i>
Coverage. This pathway covers soil or growing media containing soil, which may be traded as a commodity or moved in bulk for other purposes. Contamination of soil was specifically identified as a potential pathway in the EU risk assessments for the species above, but may apply to other species, such as those associated with plants with soil (see the list under Horticulture-Contaminant). In EU risk assessments, this pathway is generally considered minor from outside the EU because of existing prohibitions (see below), but it is identified as an important potential pathway for spread. Several of the plants above are established in Denmark. Soil is covered under other pathways if associated with: plants (see Horticulture-Contaminant), vehicles (see Transport-Vehicles), shoes (see Transport-Travellers).
Volume of the pathway. Unknown. For <i>Baccharis halimifolia</i> , this pathway is considered minor compared to intentional import as an ornamental and amenity plant.
Temporal changes. <i>Persicaria perfoliata</i> is currently unlikely to establish.
Stakeholders
<ul style="list-style-type: none"> • Soil importers • Municipalities • Landowners, garden owners • Companies carrying out building and maintenance work (e.g. roads), municipalities. • Phytosanitary authority (Landbrugstyrelsen) and authority dealing with soil pollution (Miljøstyrelsen)

<ul style="list-style-type: none"> • General public
<p>Already in place in Denmark</p> <p>Under the phytosanitary legislation, import of soil and growing media containing soil (as a commodity in itself) is prohibited from non-EU countries except from Egypt, Israel, Libya, Morocco and Tunisia (EU Directive 2000/29/EC, 2009, Annex III). There are no requirements for soil imported to Denmark from EU countries.</p> <p>No rules were found regarding invasive alien species for movement of soil within Denmark, but there are transport, treatment and deposition rules applying to soil from areas where the soil is considered chemically polluted, for which an authorization should be obtained from the municipality. It seems that movement of small quantities (below 1 m³) is generally not regulated.</p>
<p>International guidance. EPPO PRAs for invasive plants identify measures that may address soil. As for other pathways (see Horticulture-Contaminant), implementing the measures recommended in EPPO PRAs would require that the EU phytosanitary regulation is amended or a parallel regulation using similar requirements and ‘certificates’ is developed for invasive alien species as contaminants (and covering imports from within the EU and from third countries).</p>
<p>Countries for which information on measures was found. None found.</p>
<p>Possible measures</p> <p>The only measures identified in EPPO PRAs for plants are that the soil should originate from an area or place of production free from the species (e.g. <i>Heracleum sosnowskyi</i> and <i>H persicum</i>).</p> <p>Treatment, where mentioned, is considered too costly. Heat treatment or soil sterilization could be possible against <i>H. sosnowskyi</i> but may prove expensive (EPPO, 2008); Soil sterilization is considered not economically feasible for <i>Microstegium vimineum</i> (EPPO, 2016).</p> <p>Movement of soil within Denmark present a risk of spreading the species that are already present, and recommendation could be made, to relevant stakeholders (including in relation to building or maintenance), to not move soil from areas where the plants are known to occur, possibly through a system similar to soil from polluted areas. However, this would require the precise mapping, at municipality or state level, of areas presenting a risk, which may not be comprehensive for garden plants.</p> <p>Awareness-raising could also target garden owners, municipalities and others in order to not move soil from areas where the plants occur or have occurred (depending on the estimated survival and viability of seeds or plant parts in soil).</p> <p>Measures for garden owners may be difficult to apply, and it may be more effective to recommend removal of the EU List species (as done in other countries – see Horticulture-Escape).</p>
<p>Reassessment of priority. Unchanged, Medium priority (Group B). Whether measures are needed to limit the spread within Denmark would need to be evaluated based on the known distribution of the plants in Denmark.</p>
<p>References</p> <p>EPPO. 2008. EPPO PRA for <i>Heracleum sosnowskyi</i>. 08-14471</p> <p>EPPO. 2009. EPPO PRA for <i>Heracleum persicum</i></p> <p>EPPO. 2013. EPPO PRA for <i>Baccharis halimifolia</i>. 13-18359.</p> <p>EPPO. 2016. EPPO PRA for <i>Microstegium vimineum</i>. 16-21488. All available at www.eppo.int</p>

<p>OTHER CONTAMINANT: ORNAMENTAL FISH</p>
<p>Species of the EU List: Animal, <i>Orconectes limosus</i></p>
<p>Coverage. The EU risk assessment does not detail this pathway and no additional information was found. It appears to relate to contamination of fish intended for use outdoors, e.g. garden pond.</p> <p>Escapes from aquaria is covered under Aquaria-Escape.</p>
<p>Volume of the pathway. No information found.</p>
<p>Temporal changes. No information found.</p>
<p>Stakeholders. Similar as for aquatic animals under Escapes.</p>
<p>Already in place in Denmark. -</p>
<p>International guidance. -</p>
<p>Countries for which information on measures was found. -</p>
<p>Possible measure. Awareness-raising may be useful to pond owners regarding the possible contamination, and the need to pay attention to any crayfish developing in their ponds.</p>
<p>Reassessment of priority. Consider change to Very low priority (Group D) as it relates to only one species. The pathway Other-Contaminant was in Group B because of several species associated with soil.</p>

References. -

OTHER CONTAMINANT: MAN-MADE GOODS
Species of the EU List: Animal, <i>Vespa velutina</i>
Coverage. Hibernating inseminated queens of <i>Vespa velutina</i> may be associated with goods that provide suitable harbourage. The EU risk assessment mentioned ceramic pottery associated with garden trade.
Volume of the pathway. Unknown and impossible to assess. This potentially relates to a huge variety of items from areas where the wasp is present.
Temporal changes. Not considered.
Stakeholders. For ceramic pottery associated with garden trade, garden centres and garden owners. Stakeholders identified for other pathways of <i>Vespa velutina</i> (e.g. Horticulture-Contaminant).
Already in place in Denmark. -
International guidance. -
Countries for which information on measures was found. -
Possible measures This pathway covers a very broad range of products. Considering that measures targeting <i>Vespa velutina</i> may be difficult to implement also on other pathways (see above), targeting surveillance close to areas where the wasp is likely to enter (e.g. ports and airports for commodities – see Agriculture-Contaminant) or is commonly found (urban and semi-urban areas) may favour early detection (EU risk assessment), as well as general awareness.
Reassessment of priority based on measures. Consider change to Very low priority (Group D) as it relates to only one species. The pathway Other-Contaminant was in Group B because of several species associated with soil.
References. -

OTHER-ESCAPE
Species of the EU List. Animals: <i>Orconectes limosus</i>, <i>Pacifastacus leniusculus</i>
Coverage. This pathway related to the use of the species as live bait (and subsequent escape) (<i>Orconectes limosus</i> – identified as a possible source of introduction of the species into the UK) and to transport and release of individuals by fishermen into other places, for example if the caught specimen are too small (<i>Pacifastacus leniusculus</i>).
Volume of the pathway. Unknown.
Temporal changes. In the case of <i>Pacifastacus leniusculus</i> , this is probably a minor pathway compared to others. However, controlling it would help limiting spread.
Stakeholders. See Angling.
Already in place in Denmark. Recommendation to not release living bait into nature (Miljøstyrelsen website), Bekendtgørelse om udsætning af krebs i ferske vande.
International guidance. See Angling.
Countries for which information on measures was found. The Belgian regional nature conservation and fishery acts prohibits intentional release of most exotic fish species into the wild and their use as live bait for angling (Verreycken, 2015).
Possible measures. Both cases could be covered by similar measures as for Angling. Recommendations to anglers also include specific aspects in relation to baits and live specimens.
Reassessment of priority. Can be addressed under the pathway Angling (<i>Orconectes limosus</i> is already covered under that pathway).
References. Verreycken H. 2015. Risk analysis of the Amur sleeper <i>Percottus glenii</i> . INBO. May 2015.

4.9 Angling (escape, contaminant, stowaway)

ANGLING-ESCAPE, CONTAMINANT, STOWAWAY	
Species of the EU List	
Animals	Plant
<i>Orconectes limosus</i>	<i>Elodea nuttallii</i>
<i>Pseudorasbora parva</i>	
Coverage. The different modes of entry are dealt with together as they have the same audience. This relates to escape (release of live bait) for <i>Orconectes limosus</i> , contamination of live bait (<i>Pseudorasbora parva</i>).	

<p>and association with fishing boats and equipment (<i>Elodea nuttallii</i>). ‘Angling’ is a short term for the pathway, but it includes any recreational fishing.</p> <p>In addition, the combination Other-Escape relates to two species in relation to fishing and could be covered here (<i>Orconectes limosus</i> and <i>Pacifastacus leniusculus</i>), as well as the combination Escapes-Live bait (<i>Orconectes limosus</i> and <i>Pseudorasbora parva</i>).</p> <p>It was not clear if fishing takes place in the waterbody where <i>Cabomba caroliniana</i> is present (in Hedeland, close to Roskilde), and the pathway was not retained for this species. However, it may also apply to other aquatic plants present in waterbodies where fishing takes place.</p>
<p>Volume of the pathway. Unknown.</p>
<p>Temporal changes. For <i>Elodea nuttallii</i>, the pathway may become more important if it spreads within Denmark.</p>
<p>Stakeholders</p> <ul style="list-style-type: none"> • Anglers and their clubs or associations (e.g. Dansk Amatørfiskerforening, Danmarks Sportfiskerforbund), and all recreational fishing activities. • Commercial companies engaged with recreational fishing and fisheries • Authorities (Fiskeristyrelsen, Fødevarestyrelsen) that regulate recreational fisheries • Retailers selling fishing equipment, bait • General public
<p>Already in place in Denmark</p> <p>Recommendation to clean boats and fishing equipment, Recommendation to not release living bait into nature (Miljøstyrelsen website).</p> <p>The guidelines ‘Vejl. om regler for udsætning af fisk, krebs og bløddyr i de ferske vande’ prohibits release of fish and crustacean in freshwater.</p>
<p>International guidance</p> <p>European Code of Conduct on Recreational Fishing and Invasive Alien Species (Council of Europe, 2014). A Recreational Fishing Pathway Action Plan addressing invasive alien species as stowaway is provided in WGIAS (2018).</p>
<p>Countries for which information on measures was found</p> <p>Sweden. Cleaning boats material (incl. fishing gear) before entering a new water body. Not allowed to move live animals between waterbodies. Removing organisms growing on a boat before moving it (Naturvårdsverket, 2018).</p> <p>Ireland. ‘Check Clean Dry’ campaign. http://invasivespeciesireland.com/what-can-i-do/check-clean-dry/</p> <p>UK. A specific plan for the UK is provided in WGIAS (2018) and a ‘Check Clean Dry’ campaign is in place (UK, 2018).</p>
<p>Possible measures</p> <p>As detailed in the European code of conduct, WGIAS (2018) and other sources, some measures include:</p> <ul style="list-style-type: none"> • Awareness-raising to all stakeholders involved, development of awareness and education programmes, education, research, training and monitoring. • Preventing the release, spread and translocation of invasive alien species. • Ensuring that anglers and stakeholders are aware of reporting systems for invasive alien species. • Not stocking, introducing or transferring live fish or other aquatic organisms within or between catchments without permission from the authorities. • Using bait, particularly live bait, only in agreement with regulations and using aquatic organisms only in the water body from which these were collected; never transferring aquatic live bait from one water body to another. <p>Addressing equipment (boats, rods etc.) or clothing as a possible vector of invasive species:</p> <ul style="list-style-type: none"> • Including such aspects in awareness raising and education programmes for anglers. • Signage or guidance to make anglers aware of the risk and providing advice on how to prevent spread. • Where practical, limiting access to fishing areas, preferably to a single spot, with login and logout, confirming that equipment was inspected and cleaned. • If possible material (incl. nets, boats and equipment) provided on site (instead of using personal equipment). • Implementing Check, Clean, Dry procedures : informing on the correct Check Clean Dry procedures, that provide for inspection of clothing and equipment to remove any debris; cleaning on site or packing until equipment can be cleaned (which should happen without entering other watercourse or drainage system, incl. sink); drying clothing and equipment. Where boats are used, remove biofouling before

transfer to other sites, remove any collected water, use on-site trailers or carefully inspect own trailer for any water, wash water-cooled engines. Similar measures may be applicable to divers if relevant (this was not specifically mentioned for the species of the EU List).
Reassessment of priority. Upgrade to Medium priority (Group C). Individual combinations of Pathway-Mode of entry for Angling were previously considered as Very low priority (Group D), because modes of entry were rated separately. However, measures for angling as defined address all modes of entry, and they also cover cases under Other-Escape and Escapes-Live bait (i.e. 4 species in total).
References Council of Europe. 2014. Recommendation N° 170 on the European Code of Conduct on Recreational Fishing and Invasive Alien Species. Naturvårdsverket. 2018. Guidance on invasive alien species. https://www.naturvardsverket.se/Var-natur/Djur-och-vaxter/Invasiva-frammande-arter/ NNSS. 2018. Help stop the spread of invasive plants and animals in British waters. Check, Clean, Dry - GB non-native species secretariat. http://www.nonnativespecies.org/checkcleandry/ UK. 2018. Stop the spread (Poster for the Check Clean Dry Campaign). https://secure.fera.defra.gov.uk/nonnativespecies/checkcleandry/documents/check-clean-dry-england.pdf WGIAS. 2018. Prioritising Pathways of Introduction and Pathway Action Plans. Prepared by Working Group 1 of the Working Group on Invasive Alien Species (WGIAS). Date of completion: January 2018. Published in the Register of Commission Expert Groups and Other Similar Entities, code number E03276.

4.10 Ballast water and sediments

BALLAST WATER AND SEDIMENTS	
Species of the EU List	
Animal <i>Eriocheir sinensis</i>	Plants <i>Alternanthera philoxeroides</i> <i>Persicaria perfoliata</i>
Coverage. Transport of animals and plants with ballast water, and subsequent release during exchange of ballast water.	
Volume of the pathway. Only three species of the EU List were found associated with this pathway. Ballast water has been the shown or suspected pathway for the two plants in some locations. It is worth noting that this pathway was more important when considering all non-native species introduced to Denmark (Madsen et al., 2014).	
Temporal changes. The two plants are not likely to establish in Denmark currently, and <i>E. sinensis</i> is not able to reproduce in current conditions. This may change in the future. However, the progressive implementation of the provisions under the International Convention for the Control and Management of Ship's Ballast Water Sediments will also reduce the risk (see below).	
Stakeholders <ul style="list-style-type: none"> • Danish Maritime Authority / Søfartsstyrelsen (responsible for the International Convention for the Control and Management of Ship's Ballast Water Sediments) • International Maritime Organization • Shipping companies, including those based in Denmark • Professional fishing boats 	
Already in place in Denmark The International Convention for the Control and Management of Ship's Ballast Water Sediments, developed under the International Maritime Organization (IMO), entered into force in 2017. Several IMO Guidelines/Standards have been developed under the Convention. The D-1 standard (enforced in 2017, with effects from 2018) requires ballast water exchange on open seas, and requires, for all ships sailing internationally, that exchange of ballast water should happen at a location situated at least 200 nautical miles from a coast, where the depth is at least 200 m. The D-2 standard requires that ships should have on-board ballast water treatment system; this is already enforced for newly-built ship and will be implemented progressively for existing ships over the next decade. Fishing ships that have ballast water are subject to the same requirements (irrespective of their size), unless the ballast water is in sealed tanks, or if they operate only within the Danish exclusive economic zone.	
International guidance. International Convention for the Control and Management of Ship's Ballast Water	

Sediments (International Maritime Organization).
Countries for which information on measures was found. Not searched, see below.
<p>Possible measures</p> <p>The risk from ballast water is covered by the Convention above. However, liaison with the Danish Maritime Authority may be useful to monitor the progress of its implementation. Information on its efficacy to prevent the introduction of alien species may become available in the future.</p> <p>Fishing boats within Denmark are exempted from the requirements. It is not clear if this may contribute to the spread of <i>E. sinensis</i> (e.g. if there are any fishing boats in areas where it has been found in Denmark). However, <i>E. sinensis</i> has not established reproductive populations in Denmark so far.</p> <p>Reassessment of priority. Low priority (Group C) according to the classification in section 3.4. Further consideration should be given as to whether this pathway needs to be addressed for <i>E. sinensis</i> with fishing boats within Denmark. This pathway is not so important in relation to the species on the EU List, but may be more important when considering other invasive alien species.</p> <p>In addition, the species of the EU List are either not likely to establish in Denmark, or to reproduce at present. If this is taken into account, the priority may be Very low (Group D).</p> <p>References</p> <p>International Maritime Organization. http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships%27-Ballast-Water-and-Sediments-%28BWM%29.aspx Søfartstyrelsen. https://www.dma.dk/Vaekst/MiljoeKlima/Ballastvand/Sider/default.aspx</p>

4.11 Forestry (contaminant)

FORESTRY-CONTAMINANT	
Species of the EU List	
Plants	Animal
<i>Microstegium vimineum</i>	<i>Vespa velutina</i>
<i>Persicaria perfoliata</i>	
<p>Coverage. This pathway related to contamination of wood (for <i>Microstegium vimineum</i>), bark, wood and other wood products (<i>Vespa velutina</i> as hibernating inseminated queens), and plants with roots with associated soil (<i>Persicaria perfoliata</i>). Although association with plants with soil was identified for one species only, it may be relevant (including for spread within Denmark) for species that may be present in forest areas or forest nurseries. This was not analysed in details, but could be covered using measures similar to Horticulture-Contaminant., possibly with different stakeholders.</p> <p>Association with wood and wood products is considered below.</p>	
<p>Volume of the pathway</p> <p>For <i>Vespa velutina</i>, entry of hibernating queens with wood/wood products is considered to be of high importance in the EU risk assessment as they hibernate under the bark (in addition to other sites covered under other pathways).</p> <p>The pathway ‘timber’ for <i>Microstegium vimineum</i> is mentioned in the EU risk assessment but considered unlikely, and is therefore not considered further in this study.</p>	
Temporal changes. <i>Persicaria perfoliata</i> is currently unlikely to establish in Denmark.	
<p>Stakeholders</p> <ul style="list-style-type: none"> • Other authorities (phytosanitary authority – Landbrugstyrelsen, Customs) • Foresters, sawmills, etc. • General public, naturalist organisations • For <i>Vespa velutina</i>, also beekeepers and their associations, bee inspectors and Landbrugstyrelsen, as the Danish authority on beekeeping legislation 	
<p>Already in place in Denmark</p> <p>Under the phytosanitary legislation, some phytosanitary requirements apply for some bark, wood and wood products of certain tree species (conifers in particular) from certain countries outside the EU. For example, treatment may be required, which may also have an effect on <i>V. velutina</i>, and inspections would be carried out at import when a Phytosanitary Certificate is required. However, <i>Vespa velutina</i> is hibernating under the bark; it may not be noticed even during inspections, and whether treatments applied are effective against it would need further consideration. More importantly, there are no requirements on bark, wood or wood products of many tree species or countries of origin, and there are no requirements within the EU (except for wood from Portugal).</p>	

<p>International guidance</p> <p>ISPM 39 on International movement of wood contains useful general recommendations (it does not specifically mention plants as pests).</p> <p>Note : a European Code of conduct has been developed for invasive alien trees (Brundu & Richardson, 2017). It is not directly relevant for this pathway, but is relevant for forestry more generally.</p>
<p>Countries for which information on measures was found. Not searched.</p>
<p>Possible measures</p> <ul style="list-style-type: none"> • Awareness-raising for foresters, sawmills, the general public, regarding the possible association of <i>Vespa velutina</i> with wood. • <i>Vespa velutina</i>. Inspection of bark, wood and wood products at points of entry (i.e. at import), with awareness-raising and training of border staff (as recommended for other species) may detect individuals (see above). It may be possible to design similar requirements as for quarantine pests, such as pest-free area, or production under specific conditions etc. However, such requirements may not be feasible given the large range of commodities involved. Defining requirements and their applicability would require a detailed study on risk management options for Denmark. • Association of <i>P. perfoliata</i> (or other species as relevant – see Coverage above) with plants for planting with soil could be dealt with as under Horticulture-Contaminant, but may need to target different stakeholders, such as forest nurseries, foresters etc.
<p>Reassessment of priority. Very low priority (Group D). The pathway Forestry-Contaminant was in Group C, but it is unlikely for one species (<i>M. vimineum</i>), and the other two do not have a major impact. Limited measures may be available for these two species on the pathway. However, this is a major pathway for other invasive alien species.</p> <p>In addition, one of the species, <i>P. perfoliata</i> is currently not likely to establish, which would lower the priority even more in relation to the species on the EU List.</p>
<p>References</p> <p>Brundu G, Richardson D.M. 2017. European Code of conduct for invasive alien trees. https://rm.coe.int/european-code-of-conduct-for-invasive-alien-trees-adopted-version/168076e86e</p> <p>EPPO. 2016. EPPO pest risk analysis for <i>Microstegium vimineum</i>. 16-21488. EPPO, Paris, France. Available from https://www.eppo.int</p> <p>EU risk assessment for <i>Vespa velutina</i>. Marris <i>et al</i> (2011). GB Non-native Organism Risk Assessment for <i>Vespa velutina nigrithorax</i>. www.nonnativespecies.org</p> <p>ISPM 39. 2017. International movement of wood. Rome, IPPC, FAO https://www.ippc.int/static/media/files/publication/en/2017/05/ISPM_39_2017_En_2017-05-15.pdf</p>

4.12 Medicinal (escape)

MEDICINAL-ESCAPE
Species of the EU List. Plant, <i>Persicaria perfoliata</i>
Coverage. <i>Persicaria perfoliata</i> contains substances that are interesting for medicinal use, such as anticancer agents. If these properties prove interesting, the pharmaceutical research or industry may wish to produce the plant, and the plant may escape from facilities where it is held.
Volume of the pathway. Nil at present as the species is prohibited.
Temporal changes. This pathway may become relevant only if its medicinal properties proved to be very interesting in the future. <i>P. perfoliata</i> is currently not likely to establish in Denmark.
Stakeholders. Pharmaceutical research or industry
Already in place in Denmark. Not searched.
International guidance. Not searched.
Countries for which information on measures was found. Not searched.
Possible measures. Similar as to Horticulture-Escape, with awareness-raising measures towards pharmaceutical research and industry, and information on the current ban on import of this species. It is not clear whether in their search for new interesting compounds from plants, these stakeholders would be aware of the issues posed by invasive alien species.
Reassessment of priority. Very low priority (Group D), as only one species, <i>P. perfoliata</i> . This may not be a priority at all because <i>P. perfoliata</i> is not likely to establish in Denmark.
References. -

4.13 Landscaping (contaminant)

LANDSCAPING-CONTAMINANT
Species of the EU List. Plant, <i>Persicaria perfoliata</i>
Coverage. <i>Persicaria perfoliata</i> may contaminate plants imported for landscaping purposes. Although this is mentioned only for this species, it may be the case of terrestrial plants that have been considered under Horticulture-Contaminant.
Volume of the pathway. See Horticulture-Contaminant.
Temporal changes. <i>Persicaria perfoliata</i> is currently unlikely to establish in Denmark.
Stakeholders. As for Horticulture-Contaminant, as well as relevant professional (landscape architects, municipalities, foresters, etc.).
Already in place in Denmark. See Horticulture-Contaminant.
International guidance. See Horticulture-Contaminant.
Countries for which information on measures was found. See Horticulture-Contaminant.
Possible measures. See Horticulture-contaminant. Additional awareness-raising should target other stakeholders. Several EU risk assessments mention some plants that may be used for environmental purposes such as phytoremediation, wastewater treatment, and awareness-raising of relevant stakeholders (incl. research) in relation to invasive species generally may also be useful.
Reassessment of priority. Very low priority (Group D), as only one species, <i>P. perfoliata</i> . However, it may be relevant for more species on the EU List. This may not be a priority at all because <i>P. perfoliata</i> is not likely to establish in Denmark.
References. see Horticulture-Contaminant.

4.14 Overview of proposed priority changes

The proposed changes of priority for pathways compared to the priority groups in section 3.4 are illustrated below. Pathways in green changed priority. For some pathways, combinations with mode of entry and/or vectors were considered. If prioritisation was done for pathways as a whole, the priorities may change (e.g. as was done for Angling, where the initial priority was lower because modes of entries were rated separately).

Many pathways or combinations are now rated with a very low priority because they relate to only one or two species. However, if these species are considered of high priority for Denmark in another context, this may influence the priority of the pathways.

The consideration of species that are currently not able to establish in Denmark would not change the priority of pathways in Groups A and B. For others, pathways marked with * would have a lower priority than presented here (arising from ‘reassessment of priority’ for each pathway under section 4).

For several pathways, it was proposed that they could be grouped with others. The species under Other-Escape, and Escapes-Live bait could be covered under Angling. The pathway Aquaria-Contaminant applies only to *Hydrocotyle ranunculoides* and no specific measures were identified; the introduction of this plant as a contaminant could be covered by measures proposed under Horticulture-Escape (for outdoor use) and Aquaria-Escape.

There were insufficient elements to rate Escapes from public estates and parks, and its relevance for Denmark is not known (considering also that the species concerned – *Alopochen aegyptiaca* is already established and subject to measures in Denmark). The pathways Escapes from botanical gardens, Escapes from fur farms were not rated but may be or become relevant.

High
Horticulture-Escape
<i>Escapes</i>
Aquaria-Escape
Secondary Introduction
Medium
Horticulture-Contaminant
Aquaculture-Contaminant
<i>Other-Contaminant</i>
<i>Transport</i>
<i>Agriculture-Contaminant</i>
Low
Aquaculture-Escape
Ballast
<i>Other-Escape</i>
<i>Forestry-Contaminant</i>
Very low
Agriculture-Escape
Aquarium-Contaminant
Landscaping-Contaminant
Medicinal-Escape
<i>Angling-Escape</i>
<i>Angling-Contaminant</i>
<i>Angling-Stowaway</i>

As per section 3

High
Horticulture-Escape
<i>Escapes-Pets</i>
<i>Escapes-Zoos</i>
Aquaria-Escape
Secondary Introduction
Medium
Horticulture-Contaminant
Aquaculture-Contaminant
<i>Other-Contaminant - Soil</i>
<i>Transport-Travellers</i>
<i>Transport- Vehicles and means of conveyance</i>
↑Angling (Escape, Contaminant, Stowaway), grouped with Other-Escape and Escape-Live bait
Low
Aquaculture-Escape
Ballast*
↓ <i>Transport-Livestock</i>
Very low
Agriculture-Escape*
Aquaria-Contaminant (may be grouped with Aquaria-Escape)
Landscaping-Contaminant*
Medicinal-Escape*
↓ <i>Agriculture – Contaminant: Bird seeds*</i>
↓ <i>Agriculture – Contaminant: Grain and seeds*</i>
↓ <i>Agriculture – Contaminant: fruit and cut flowers</i>
↓ <i>Escapes: Live food for consumption</i>
↓ <i>Transport-Leisure boat</i>
↓ <i>Other-Contaminant-Man-made goods</i>
↓ <i>Other-Contaminant-Ornamental Fish</i>
↓ <i>Forestry-Contaminant</i>

As per section 4

Fig. 14. Comparison of priorities in section 3 with reassessed priorities in section 4 (no specific order intended within each group)

In green, pathways for which the priority category has changed.

In orange, pathways that were divided between several vectors.

↑↓ increase/decrease of priority

* the pathway (or combination) would have a lower priority if taking into account species that are currently unlikely to establish in Denmark.

5. Conclusion

The study proposed priority pathways for the species on the EU List. Some pathways have a high priority because of the species on the EU List and the habitats they invade. Secondary introduction was not as major in Madsen et al. (2014) as it is here, but this is due to the current distribution of the species of the EU List. On the contrary, the pathways Agriculture, Forestry, Landscaping or Ballast water rate much lower than in Madsen et al. (2014).

Defining the relevance of individual pathways for Denmark for each species was not always straightforward as the EU risk assessments sometimes clearly focused on one or few European countries. A better assessment would require a detailed analysis and adjustment of the EU risk assessments to the Danish situation. Similarly, pathways for one species were given the same weight, because data was not available to assess

which pathway was more important for Denmark. If such data becomes available, the basis for prioritizing would be enhanced. The present analysis could also be refined by involving experts of the taxonomic groups involved. Nevertheless it provides a first prioritization that may then be taken further in deciding priority pathways for Denmark.

Potential measures were identified and would need to be further considered in view of their cost-effectiveness, feasibility and acceptability in Denmark, as well as the importance of the pathways in the national strategy. For most pathways, the need for awareness-raising and communication was identified, and the development of a general strategy for Denmark would be useful. Surveillance and early detection, as well as the availability and promotion of user-friendly reporting tools, is important for most pathways as measures available may not be sufficient to prevent introductions. Finally, prompt action in case of detection is highlighted for many species. Spread within Denmark plays an important role for those species that are already established, but deciding on potential management may necessitate a further prioritization of the species.

In this context of public awareness and outreach, it should be suggested and encouraged to cooperate with authorities responsible for invasive species in relation with plant health (quarantine pests and diseases) since many of these will have major impact on biodiversity as well.

The development of detailed definitions for the CBD categories and subcategories of pathways would help making the transition for those countries, like Denmark, which have used their own systems until now. This would avoid differences of interpretation of categories, and allow maintaining consistency over many species.

The study also shows the importance of an agreed terminology and its consistent use in applying EU Regulation 1143/2014. Because of the diversity of animals and plants on the EU List, expertise is drawn from many different domains, which may use terms differently. Fully harmonized concepts and terms would be useful to allow for a common understanding throughout the EU. For example the term 'release' is sometimes used to relate to escape, such as garden waste 'released' in nature for some assessors constituting an escape from horticulture for others.

Valuable guidance has already been given regarding the prioritization of pathways (e.g. in WGIAS, 2018). However, because each EU Member State performs the prioritization of pathways separately, there will presumably be very different methodologies applied, for example whether the total impact of species is used or specific biological impact. It would be interesting to compare the methodologies used in order to refine the guidance on this issue using the experience in countries.

Finally, sharing of best practices between countries will facilitate implementation of action plans on priority pathways. Limited information was found on the cost-effectiveness of measures, which would also help addressing pathways. It would also be interesting to review in appropriate fora the prioritization performed by all EU Member States in order to identify whether some pathways are of high priority for all Member States and EU guidance/recommendations could be developed.

6. References (for individual pathways, see in section 4)

- Blackburn T.M., Essl F., Evans T., Hulme P.E., Jeschke J.M., Kühn I., Kumschick S., Marková Z., Mrugała A., Nentwig W., Pergl J., Pyšek P., Rabitsch W., Ricciardi A., Richardson D.M., Sendek A., Vilà M., Wilson J.R., Winter M., Genovesi P., Bacher S. 2014. A Unified Classification of Alien Species Based on the Magnitude of their Environmental Impacts. *PLoS Biol* 12(5): e1001850. doi:10.1371/journal.pbio.1001850.
- CBD. 2014. UNEP/CBD/SBSTTA/18/9/Add.1. Pathways of Introduction of Invasive Species, their Prioritization and Management. Subsidiary Body on Scientific, Technical and Technological Advice, Eighteenth meeting, Montreal, 23-28 June 2014.
- EU. 2014a. EU Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species. L317/35. 4.11.2014.
- EU. 2014b. Fiches on proposed list of invasive alien species of Union concern.
- Hulme P.E., Bacher S., Kenis M., Klotz S., Kühn I., Minchin D., Nentwig W., Olenin S., Panov V., Pergl J., Pyšek P., Roques A., Sol D., Solarz W., Vilà M. 2008. Grasping at the routes of biological invasions: a framework for integrating pathways into policy. *Journal of Applied Ecology* 45: 403-414.
- IUCN, 2017. Environmental Impact Classification of Alien Taxa (EICAT). Brochure.
- Madsen C.L., Dahl C.M., Thirslund K.B., Grousset F., Johannsen V.K., Ravn H.P. 2014. Pathways for non-native species in Denmark. Department of Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg. 131 pp.
- McGeoch M., Genovesi P., Bellingham P., Costello M., McGrannachan C., Sheppard A. 2016. Prioritising species, pathways, and sites to achieve conservation targets for biological invasion. *Biological Invasions* 19: 299-314.
- NOBANIS. 2015. Invasive Alien Species. Pathway Analysis and Horizon Scanning for Countries in Northern Europe. *TemaNord* 2015:517. Nordic Council of Ministers 2015.
- Roy H., et al. 2014. ARES(2014)2425342 - 22/07/2014. Organisation and running of a scientific workshop to complete selected invasive alien species (IAS) risk assessments. Natural Environment Research Council. Available at <http://nora.nerc.ac.uk/id/eprint/510663/>.
- Scalera R., Genovesi P. 2016. Guidance for Governments concerning Invasive Alien Species Pathways Action Plans - Final Draft - June 2016. Convention on the Conservation of European Wildlife and Natural Habitats. Standing Committee 36th meeting Strasbourg, 15-18 November 2016. T-PVS/Inf (2016) 10.
- Strandberg B. 2017. Vurdering af invasive arteres forekomst og påvirkninger i Danmark. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi, 88 s. – Teknisk rapport fra DCE - Nationalt Center for Miljø og Energi nr. 96 <http://dce2.au.dk/pub/TR96.pdf>
- WGIAS. 2018. Prioritising Pathways of Introduction and Pathway Action Plans. Prepared by Working Group 1 of the Working Group on Invasive Alien Species (WGIAS). Date of completion: January 2018. Published in the Register of Commission Expert Groups and Other Similar Entities, code number E03276.

Appendix 1. Terminology used and comparison with CBD classification

Type of Introduction

Madsen et al. (2014) and present study	CBD classification (CBD, 2014)
Type of introduction	Mechanism
Intentional	Commodity
Non-intentional	Vector, Spread

Mode of entry

Madsen et al. (2014) and present study	CBD classification (CBD, 2014)
Mode of entry	Pathway Category
Release	Release
Escape	Escape
Contaminant	Contaminant
stowaway	stowaway
corridor	corridor
unaided	unaided
Not known	

Pathway and subcategory (vectors)

The table below presents the CBD classification terms corresponding to pathways in Madsen et al. (2014) and the present study. The subcategory level in Madsen et al. (2014) (or ‘vectors’) often goes beyond the CBD classification, and the pathways are sometimes more detailed. A pathway subcategory in the CBD classification may apply to several pathways in Madsen et al. (2014), e.g. ‘Contaminant on plants (except parasites, species transported by host/vector)’ (CBD) may apply to ‘Agriculture’, ‘Horticulture’, ‘Forestry’, and/or ‘Landscaping’. On the other hand, CBD subcategories may cover cases that were not detailed (as not needed) in Madsen et al. (2014), e.g. ‘release in nature for use for fur or transport’.

Some CBD subcategories divide between two pathways in Madsen et al. (2014) (e.g. Pet/aquarium/terrarium species), and the part which is not relevant is put into brackets below []

This table is for information, and does not constitute an agreed list.

Madsen et al. (2014) and present study			Corresponding pathways in CBD classification		
Pathway of introduction	Associated modes of entry	Subcategory: vectors	Mechanism	Category	Subcategory
AGRI - Agriculture	ESC - Escape, CON - Contaminant	Cuttings Fruits and vegetables Bird Seeds Grain Plants with roots Seeds Stored products (other than grain) Other	Commodity	Escape Contaminant	Agriculture (including biofuel feedstocks) Live food [and live baits] Contaminant on plants (except parasites, species transported by host/vector) Parasites on plants (including species transported by host and vector) Seed contaminant Transportation of habitat material (soil, vegetation,...)
ANGL - Angling/Sport	Release, Escape, Contaminant, STO - Stowaway	Fishing material	Commodity	Release Escape Contaminant Stowaway	Fishery in the wild (including game fishing) [Live food and]live bait Contaminated bait Angling/fishing equipment
ANIM - Animal husbandry	Contaminant	(As contaminant)	Commodity	Contaminant	Contaminant on animals (except parasites, species transported by host/vector)

Madsen et al. (2014) and present study			Corresponding pathways in CBD classification		
					Parasites on animals (including species transported by host and vector)
AQUC - Aquaculture	Escape, Contaminant		Commodity	Escape Contaminant	Aquaculture / mariculture Contaminant on animals (except parasites, species transported by host/vector) Parasites on animals (including species transported by host and vector)
AQUA - Aquaria	Escape, Contaminant		Commodity	Escape Contaminant	[Pet]/aquarium/terrarium species (including live food for such species) Contaminant on animals (except parasites, species transported by host/vector) Parasites on animals (including species transported by host and vector)
BALL - Ballast water and sediments	Stowaway		Vector	Stowaway	Ship/boat ballast water
BIOC - Biological Control	Release		Commodity	Release	Biological control
COMC - Commodity contaminants	Contaminant		Commodity	Contaminant	Food contaminant (including of live food)
ESCS - Escape	Escape	Botanical gardens Breeding farms Farms Confinement Pets Research Zoo Other	Commodity	Escape	Botanical garden/zoo/aquaria (excluding domestic aquaria) Farmed animals (including animals left under limited control) Fur farms Pet/aquarium/terrarium species (including live food for such species) Research and <i>ex-situ</i> breeding (in facilities) Live food and live bait Other escape from confinement
FORE - Forestry	Escape, Contaminant	Bark and wood chips Plants with roots (Incl. Pot plants) Sawn wood (Processed) Seeds Timber (Round wood) Wood packaging material Other	Commodity	Escape Contaminant	Forestry (including afforestation or reforestation) Nursery material Timber trade Contaminant on plants (except parasites, species transported by host/vector) Parasites on plants (including species transported by host and vector) Seed contaminant Transportation of habitat material (soil, vegetation,...)
HORT - Horticulture	Escape, Contaminant	Cut flowers and branches Cuttings Plants with roots (Incl. Pot plants)	Commodity	Escape Contaminant	Horticulture Nursery material Contaminant on plants (except parasites, species transported

Madsen et al. (2014) and present study			Corresponding pathways in CBD classification		
		Seeds Other			by host/vector) Parasites on plants (including species transported by host and vector) Seed contaminant Transportation of habitat material (soil, vegetation,...)
HULL - Hull fouling	Stowaway		Vector	Stowaway	Ship/boat hull fouling
HUNT - Hunting	Release		Commodity	Release	Hunting
LAND - Landscaping	Release, Contaminant	Cuttings Plants with roots (incl. pot plants) Seeds Erosion Control Other	Commodity	Release Escape Contaminant	Erosion control/ dune stabilization (windbreaks, hedges, ...) Landscape/flora/fauna "improvement" in the wild Nursery material Transportation of habitat material ([soil], vegetation,...) Contaminant on plants (except parasites, species transported by host/vector) Parasites on plants (including species transported by host and vector) Seed contaminant Transportation of habitat material ([soil], vegetation,...)
MEDI - Medicinal	Release, Escape	Cuttings Plants with roots (Incl. Pot plants) Seeds Other	Commodity	Release	Release in nature for use (other than above, e.g., [fur, transport], medical use)
REIN - Reintroduction					
SEIN - Secondary introduction	Corridor, Unaided		Spread	Corridor Unaided	Interconnected waterways/basins/seas Tunnels and land bridges Natural dispersal across borders of invasive alien species that have been introduced through [other] pathways
TRAN - Transport	Stowaway	Agricultural machinery Aircraft/car/truck/train/ship/leisure boat Military Packaging material (Except wood packaging material) Peoples baggage Other	Vector	Stowaway	Container/bulk Hitchhikers in or on airplane Hitchhikers on ship/boat (excluding ballast water and hull fouling) Machinery/equipment People and their luggage/equipment (in particular tourism) Organic packing material, in particular wood packaging Vehicles (car, train, ...) Other means of transport
OTHR - Other	Release, Escape, Contaminant, Stowaway		Commodity	Release	Introduction for conservation purposes or wildlife management Ornamental purpose other than

Madsen et al. (2014) and present study			Corresponding pathways in CBD classification		
				Contaminant	horticulture* Release in nature for use (other than above, e.g., fur, transport, [medical use])* Other intentional release Transportation of habitat material (soil, [vegetation],...) **
NOTK - Not known					

* the CBD classification seems to apply ‘Release in nature for Ornamental purpose other than horticulture’ to the release of e.g. certain birds, which is relevant for some species on the EU List.

** Madsen et al. (2014) and the present study cover contamination of soil as a commodity as ‘Other (Soil)’

Appendix 2. Species on the EU List, status in Denmark, pathways, scores

In the column « Pathways for DK », unintentional pathways are in bold

Species name	Group	Terrestrial Aquatic	Status in Denmark	Type of introduction	Mode of entry	Pathway for DK (introduction and spread for species present in DK)	Dispersal potential	Colonisation of high value conservation habitats	Adverse impacts on native species	Alteration of ecosystems functions	Economic impact	Effects on human health	Score Biological damage	Score Harmonia	Total score
<i>Alopochen aegyptiaca</i>	Aves	terrestrial	Established	Intentional & Unintentional	Escape, Release, Unaided	Escapes (zoos, other: private collections), Other (release into public estates and parks), Secondary introduction	3	3	2	1	1	1	3	9	11
<i>Alternanthera philoxeroides</i>	Angiosperms	aquatic	Not Established (and currently not likely to)	Intentional & Unintentional	Escape, Contaminant, Stowaway	Horticulture, Aquaria, Ballast water & sediments, Agriculture (Bird seeds, Fruits and vegetables, plants)	3	3	3	3	3	1	6	12	16
<i>Asclepias syriaca</i>	Angiosperms	terrestrial	Not established	Intentional & Unintentional	Release, Escape, Corridor, Unaided	Horticulture, Agriculture, Secondary introduction , Other (release for beekeeping)	3	3	2	1	3	2	3	9	14
<i>Baccharis halimifolia</i>	Angiosperms	terrestrial	Not Established	Intentional & Unintentional	Escape, Release, Contaminant, Stowaway	Horticulture (plants with roots, seeds), Landscaping (plants with roots, seeds), Transport (machinery, vehicles), Other (contaminated soil)	3	2	3	3	2	2	6	11	15
<i>Cabomba caroliniana</i>	Angiosperms	aquatic	Established	Intentional	Escape	Horticulture, Aquaria, Secondary introduction	2	2	2	2	2	1	4	8	11
<i>Callosciurus erythraeus</i>	Mammalia	terrestrial	Not Established	Intentional	Escape	Escape (pets, zoos)	3	2	2	1	2	1	3	8	11
<i>Corvus splendens</i>	Aves	terrestrial	Not Established	Unintentional	Stowaway, Unaided	Transport (ship), Secondary introduction	2	2	2	1	1	1	3	7	9
<i>Eichhornia crassipes</i>	Angiosperms	aquatic	Not Established (and currently not likely to)	intentional	Escape	Horticulture, Aquaria	3	3	3	2	1	3	5	11	15
<i>Elodea nuttallii</i>	Angiosperms	aquatic	Established	Intentional, unintentional	Escape, Stowaway, Unaided	Aquaria, Horticulture, Secondary introduction, Angling/sport [spread], Transport (Leisure boats) [spread]	3	3	3	3	2	1	6	12	15

Species name	Group	Terrestrial Aquatic	Status in Denmark	Type of introduction	Mode of entry	Pathway for DK (introduction and spread for species present in DK)	Dispersal potential	Colonisation of high value conservation habitats	Adverse impacts on native species	Alteration of ecosystems functions	Economic impact	Effects on human health	Score Biological damage	Score Harmonia	Total score
<i>Eriocheir sinensis</i>	Arthropoda	aquatic	Established	Intentional, unintentional	Stowaway, Unaided, Escape	Ballast water & sediments, Secondary introduction, Escapes (other: live food for consumption)	3	3	2	2	3	1	4	10	14
<i>Gunnera tinctoria</i>	Angiosperms	terrestrial	Not Established	intentional	Escape	Horticulture	3	3	3	3	3	2	6	12	17
<i>Heracleum mantegazzianum</i>	Angiosperms	terrestrial	Established	Intentional & unintentional	Escape, Contaminant, Unaided	Horticulture, Other (soil), Secondary introduction	3	3	3	3	3	2	6	12	17
<i>Heracleum persicum</i>	Angiosperms	terrestrial	Established	Intentional, unintentional	Escape, Contaminant, Stowaway, Release	Horticulture, Transport (machinery, vehicles, other: footwear, livestock), Other (soil, beekeeping), Transport (cars, other: shoes) [spread], Secondary introduction [spread]	3	3	3	3	2	2	6	12	16
<i>Heracleum sosnowskyi</i>	Angiosperms	terrestrial	Established	intentional	Contaminant, Stowaway	Other (soil), Transport (machinery, vehicles, other: footwear, livestock), Secondary introduction [spread]	3	3	3	3	2	2	6	12	16
<i>Herpestres javanicus</i>	Mammalia	terrestrial	Not Established (and currently not likely to)	intentional & unintentional	Escape, Stowaway	Escape (pets), Transport (ship)	3	3	3	1	1	1	4	10	12
<i>Hydrocotyle ranunculoides</i>	Angiosperms	aquatic	Not Established	Intentional & Unintentional	Release, Escape, Contaminant,	Horticulture (plants with roots), Aquaria, Landscaping (other)	1	3	3	3	2	2	6	10	14
<i>Impatiens glandulifera</i>	Angiosperms	terrestrial	Established	Intentional & unintentional	Escape, Release, Unaided	Horticulture, Other (beekeeping), Secondary introduction	3	3	3	2	2	1	5	11	14
<i>Lagarosiphon major</i>	Angiosperms	aquatic	Not Established	intentional	Escape	Aquaria, Horticulture	3	2	3	3	3	1	6	11	15
<i>Lithobates catesbeiana</i>	Reptilia & amphibia	aquatic	Not Established	intentional	Escape, Contaminant	Escapes (pets, zoos), Aquaria, Aquaculture	1	2	2	1	1	1	3	6	8
<i>Ludwigia grandiflora</i>	Angiosperms	aquatic	Not Established	Intentional	Escape	Aquaria, Horticulture	3	3	3	2	3	1	5	11	15

Species name	Group	Terrestrial Aquatic	Status in Denmark	Type of introduction	Mode of entry	Pathway for DK (introduction and spread for species present in DK)	Dispersal potential	Colonisation of high value conservation habitats	Adverse impacts on native species	Alteration of ecosystems functions	Economic impact	Effects on human health	Score Biological damage	Score Harmonia	Total score
<i>Ludwigia peploides</i>	Angiosperms	aquatic	Not Established	Intentional	Escape	Horticulture (plants with roots, seeds)	3	3	3	2	3	1	5	11	15
<i>Lysichiton americanus</i>	Angiosperms	terrestrial	Established	intentional	Escape, Release	Horticulture (seeds, plants with roots), Landscaping, Transport (agricultural machinery, animals (as seeds)) [spread], Secondary introduction [spread]	2	2	3	2	1	1	5	9	11
<i>Microstegium vimineum</i>	Angiosperms	terrestrial	Not Established	Unintentional	Contaminant, Stowaway	Agriculture (birdseeds, other: hay; plants with roots [with soil]), Other (soil), Horticulture (plants with roots [with soil], Forestry (plants with roots [with soil], timber), Transport (agricultural machinery, cars, trucks, other: travellers shoes or clothes)	2	2	3	2	1	1	5	9	11
<i>Muntiacus reevesii</i>	Mammalia	terrestrial	Not Established	intentional	Escape, Release	Hunting, Escape (zoo, pets), Secondary Introduction [spread]	3	2	3	3	1	1	6	11	13
<i>Myocastor coypus</i>	Mammalia	terrestrial	Not Established (and currently not likely to)	intentional	Escape	Escapes (zoos)	2	3	3	2	1	1	5	10	12
<i>Myriophyllum aquaticum</i>	Angiosperms	aquatic	Not Established	Intentional	Escape	Aquaria, Horticulture	2	2	3	2	2	1	5	9	12
<i>Myriophyllum heterophyllum</i>	Angiosperms	aquatic	Not Established	Intentional	Escape	Aquaria, Horticulture	2	2	3	2	2	1	5	9	12
<i>Nasua nasua</i>	Mammalia	terrestrial	Not Established	intentional & unintentional	Escape	Escape (zoos, pets)	3	3	3	1	1	1	4	10	12
<i>Nyctereutes procyonoides</i>	Mammalia	terrestrial	Established	intentional & unintentional	Unaided, Escape	Escapes (pets), Secondary introduction	3	3	3	3	3	2	6	12	17
<i>Ondatra zibethicus</i>	Mammalia	terrestrial	Established	intentional & unintentional	Escape, Unaided	Escapes (pets), Secondary introduction	3	3	3	2	2	1	5	11	14

Species name	Group	Terrestrial Aquatic	Status in Denmark	Type of introduction	Mode of entry	Pathway for DK (introduction and spread for species present in DK)	Dispersal potential	Colonisation of high value conservation habitats	Adverse impacts on native species	Alteration of ecosystems functions	Economic impact	Effects on human health	Score Biological damage	Score Harmonia	Total score
<i>Orconectes limosus</i>	Arthropoda	aquatic	Not Established	Intentional, Unintentional	Escape, Contaminant, Unaided	Aquaria, Angling/sport, Transport (peoples baggage), Other (release of live bait, contaminant of 'ornamental' fish), Secondary introduction	3	3	3	1	1	1	4	10	12
<i>Orconectes virilis</i>	Arthropoda	aquatic	Not Established	Intentional	Escape	Aquaria	3	3	3	1	1	1	4	10	12
<i>Oxyura jamaicensis</i>	Aves	terrestrial	Not Established	Intentional & Unintentional	Escape, Unaided	Secondary introduction, Escapes (pets, zoos, other: private collections)	3	3	3	1	2	1	4	10	13
<i>Pacifastacus leniusculus</i>	Arthropoda	aquatic	Established	intentional	Escape, Unaided, Contaminant	Aquaculture, Secondary introduction, Other (release of fished individuals) [spread]	3	3	3	3	3	1	6	12	16
<i>Parthenium hysterophorus</i>	Angiosperms	terrestrial	Not Established (and currently not likely to)	unintentional	Contaminant, Stowaway	Agriculture (grain, seed), Horticulture (plants for planting with growing media), Transport (agricultural machinery, peoples baggage, other: travellers clothes and shoes)	3	3	3	2	1	3	5	11	15
<i>Pennisetum setaceum</i>	Angiosperms	terrestrial	Not Established	Intentional, unintentional	Release, Escape, Contaminant, Stowaway	Horticulture (Plants with root, Seeds), Landscaping (erosion control), Transport (agricultural machinery, vehicles, other: livestock)	1	2	2	2	1	1	4	7	9
<i>Percottus glenii</i>	Pisces	aquatic	Not Established	Intentional, unintentional	Escape, Contaminant, Unaided	Aquaria, Aquaculture, Secondary introduction	3	3	3	1	1	1	4	10	12
<i>Persicaria perfoliata</i>	Angiosperms	terrestrial	Not Established (and currently not likely to)	intentional & unintentional	Contaminant, Stowaway, Release	Horticulture (plants with roots with associated soil), Landscaping (plants with roots with associated soil), Medicinal, Forestry (plants with roots with associated soil), Other (soil), Ballast water	2	2	2	2	1	1	4	8	10
<i>Procambarus</i>	Arthropoda	aquatic	Not Established	Intentional, Unintentional	Escape, Unaided	Aquaria, Aquaculture, Escapes (other: live food for consumption),	3	3	3	2	1	1	5	11	13

Species name	Group	Terrestrial Aquatic	Status in Denmark	Type of introduction	Mode of entry	Pathway for DK (introduction and spread for species present in DK)	Dispersal potential	Colonisation of high value conservation habitats	Adverse impacts on native species	Alteration of ecosystems functions	Economic impact	Effects on human health	Score Biological damage	Score Harmonia	Total score
<i>clarkii</i>						Secondary Introduction									
<i>Procambarus fallax</i> <i>spp. virginalis</i>	Arthropoda	aquatic	Not Established	Intentional, Unintentional	Escape, Unaided	Aquaria, Secondary Introduction	3	3	3	2	1	1	5	11	13
<i>Procyon lotor</i>	Mammalia	terrestrial	Not established	Intentional & Unintentional	Escape, Unaided	Escapes (pets, zoos), Secondary introduction	3	3	3	3	2	2	6	12	16
<i>Pseudorasbora</i> <i>parva</i>	Pisces	aquatic	Established	Intentional, Unintentional	Escape, Unaided, Contaminant	Angling/sport (contaminant of live bait), Aquaria, Escapes (pets, other: live bait), Aquaculture, Secondary spread	2	2	3	2	2	1	5	9	12
<i>Pueraria lobata</i>	Angiosperms	terrestrial	Not Established (and currently not likely to)	Intentional	Release, Escape	Horticulture (seeds, plants with roots), Agriculture (seeds, plants with roots, other), Landscaping (Erosion control, other)	2	3	3	1	1	1	4	9	11
<i>Sciurus</i> <i>carolinensis</i>	Mammalia	terrestrial	Not established	Intentional	Escape	Escapes (pets, zoos)	3	3	3	3	2	1	6	12	15
<i>Sciurus niger</i>	Mammalia	terrestrial	Not Established	Intentional	Escape	Escapes (pets, zoos)	3	3	3	1	1	1	4	10	12
<i>Tamias sibiricus</i>	Mammalia	terrestrial	Not established	intentional	Escape, Unaided	Escapes (pets), Secondary introduction	2	1	1	2	1	1	3	6	8
<i>Threskiornis</i> <i>aethiopicus</i>	Aves	terrestrial	Not established	Intentional, unintentional	Escape, Unaided	Escapes (zoos, other: private collections), Secondary introduction	1	1	1	1	1	1	2	4	6
<i>Trachemys scripta</i> <i>elegans</i>	Reptilia & amphibia	aquatic	Established	Intentional	Escape	Escapes (pets), Aquaria	2	1	2	1	1	1	3	6	8
<i>Trachemys scripta</i> <i>scripta</i>	Reptilia & amphibia	aquatic	Established	Intentional	Escape	Escapes (pets), Aquaria	2	1	2	1	1	1	3	6	8
<i>Trachemys scripta</i> <i>troosti</i>	Reptilia & amphibia	aquatic	Not Established	Intentional	Escape	Escapes (pets), Aquaria	2	1	2	1	1	1	3	6	8

Species name	Group	Terrestrial Aquatic	Status in Denmark	Type of introduction	Mode of entry	Pathway for DK (introduction and spread for species present in DK)	Dispersal potential	Colonisation of high value conservation habitats	Adverse impacts on native species	Alteration of ecosystems functions	Economic impact	Effects on human health	Score Biological damage	Score Harmonia	Total score
<i>Vespa velutina nigrithorax</i>	Arthropoda	terrestrial	Not Established	unintentional	Contaminant, Unaided	Forestry (bark, wood, other: wood products), Other (man-made goods), Agriculture (fruits and vegetables, Plants with roots with associated soil), Horticulture (Plants with roots with associated soil), Transport (transport vehicles, incl. ship and planes, other: freight containers), Secondary introduction	3	1	3	2	3	1	5	9	13

Appendix 3. Combinations of pathways-Modes of entry for each species

Species marked with * are currently unlikely to establish

Species name	Group	AGRI-ESC	AGRI-CON	ANGL-ESC	ANGL-CON	ANGL-STO	ANIM	AQUC-ESC	AQUC-CON	AQUA-ESC	AQUA-CON	BALL	ESCS	FORE-CON	HORT-ESC	HORT-CON	LAND-CON	MEDI-ESC	OTHR-ESC	OTHR-CON	SEIN	SEIN (spread only)	TRAN	TRAN (spread only)
<i>Alopochen aegyptiaca</i>	Aves												1						1		1			
<i>Alternanthera philoxeroides</i> *	Angiosperms		1							1		1				1	1							
<i>Asclepias syriaca</i>	Angiosperms	1														1					1			
<i>Baccharis halimifolia</i>	Angiosperms															1				1			1	
<i>Cabomba caroliniana</i>	Angiosperms									1						1						1		
<i>Callosciurus erythraeus</i>	Mammalia												1											
<i>Corvus splendens</i>	Aves																				1		1	
<i>Eichhornia crassipes</i> *	Angiosperms									1						1								
<i>Elodea nuttallii</i>	Angiosperms					1				1						1					1			1
<i>Eriocheir sinensis</i>	Arthropods											1	1								1			
<i>Gunnera tinctoria</i>	Angiosperms															1								
<i>Heracleum mantegazzianum</i>	Angiosperms															1				1	1			
<i>Heracleum persicum</i>	Angiosperms															1				1		1	1	1
<i>Heracleum sosnowskyi</i>	Angiosperms																			1		1	1	
<i>Herpestres javanicus</i> *	Mammalia												1										1	
<i>Hydrocotyle ranunculoides</i>	Angiosperms									1	1					1	1							
<i>Impatiens glandulifera</i>	Angiosperms															1					1			
<i>Lagarosiphon major</i>	Angiosperms									1						1								
<i>Lithobates catesbeiana</i>	Reptilia & amphibians									1	1			1										
<i>Ludwigia grandiflora</i>	Angiosperms									1						1								
<i>Ludwigia peploides</i>	Angiosperms															1								
<i>Lysichiton americanus</i>	Angiosperms															1						1		1
<i>Microstegium vimineum</i>	Angiosperms		1											1			1			1			1	
<i>Muntiacus reevesii</i>	Mammalia												1									1		
<i>Myocastor coypus</i> *	Mammalia												1											
<i>Myriophyllum aquaticum</i>	Angiosperms									1						1								
<i>Myriophyllum heterophyllum</i>	Angiosperms									1						1								
<i>Nasua nasua</i>	Mammalia												1											
<i>Nyctereutes procyonoides</i>	Mammalia												1								1			

Species name	Group	AGRI-ESC	AGRI-CON	ANGL-ESC	ANGL-CON	ANGL-STO	ANIM	AQUC-ESC	AQUC-CON	AQUA-ESC	AQUA-CON	BALL	ESCS	FORE-CON	HORT-ESC	HORT-CON	LAND-CON	MEDI-ESC	OTHR-ESC	OTHR-CON	SEIN	SEIN (spread only)	TRAN	TRAN (spread only)
<i>Ondatra zibethicus</i>	Mammalia												1								1			
<i>Orconectes limosus</i>	Arthropods			1						1									1	1	1		1	
<i>Orconectes virilis</i>	Arthropods									1														
<i>Oxyura jamaicensis</i>	Aves												1								1			
<i>Pacifastacus leniusculus</i>	Arthropods							1	1										1		1			
<i>Parthenium hysterophorus*</i>	Angiosperms		1														1						1	
<i>Pennisetum setaceum</i>	Angiosperms														1								1	
<i>Percottus glenii</i>	Pisces								1	1											1			
<i>Persicaria perfoliata*</i>	Angiosperms											1		1		1	1	1		1				
<i>Procambarus clarkii</i>	Arthropods							1		1			1								1			
<i>Procambarus fallax virginalis</i>	Arthropods									1											1			
<i>Procyon lotor</i>	Mammalia												1								1			
<i>Pseudorasbora parva</i>	Pisces				1				1	1			1								1			
<i>Pueraria lobata*</i>	Angiosperms	1													1									
<i>Sciurus carolinensis</i>	Mammalia												1											
<i>Sciurus niger</i>	Mammalia												1											
<i>Tamias sibiricus</i>	Mammalia												1								1			
<i>Threskiornis aethiopicus</i>	Aves												1								1			
<i>Trachemys scripta elegans</i>	Reptilia									1			1											
<i>Trachemys scripta scripta</i>	Reptilia									1			1											
<i>Trachemys scripta troosti</i>	Reptilia									1			1											
<i>Vespa velutina nigrithorax</i>	Arthropods		1											1		1				1	1		1	

UNIVERSITY OF COPENHAGEN
DEPARTMENT OF GEOSCIENCES
AND RESOURCE MANAGEMENT

ROLIGHEDSVEJ 23
DK-1958 FREDERIKSBERG

TEL. +45 35 33 15 00
IGN@IGN.KU.DK
WWW.IGN.KU.DK